



Memorandum

To: *Stephanie Vaughn, EPA Region 2*
Elizabeth Buckrucker, USACE

From: *Frank Tsang and Sharon Budney*

Date: *December 23, 2011*

Subject: *2009 and 2010 Sediment Split Sample Data Comparison and Comments on the CPG Draft 2009 and 2010 Sediment Chemistry Data for the Lower Passaic River Study Area, September 2, 2011*

At the request of the United State Environmental Protection Agency (EPA) and the United States Army Corps of Engineers (USACE), CDM Federal Programs Corporation (CDM) reviewed the Draft 2009 and 2010 Sediment Chemistry Data report for the Lower Passaic River Study Area, dated September 2, 2011, prepared by Windward Environmental LLC on behalf of the Cooperating Parties Group (CPG) for the Lower Passaic River (LPR) Restoration Project.

As a part of the 2009 LPR investigation the Louis Berger Group, Inc. (LBG) collected oversight split samples of sediment for laboratory analysis during the 2009 Fish and Benthic Tissue Sampling program conducted by the Cooperating Parties Group (CPG) for the LPR Remedial Investigation (RI). Subsequently, CDM was requested to collect oversight split sediment samples for laboratory analysis during the 2010 Fish and Benthic Tissue Sampling program conducted by the CPG for the LPR RI.

The following is a combination of information extracted from LBG's memorandum of September 27, 2011 titled *Split Sample Data Comparison 2009 Lower Passaic River Sediment, Fish and Benthic Tissue Sampling Oversight*, appended with CDM's 2010 split sampling data. The data presented on the attached table and figures have been modified from the LBG document to incorporate both the 2009 (LBG) and 2010 (CDM) split sample sediment data.

This memorandum presents the comparison of the CPG's sample results to the EPA oversight teams' split sample results and discusses the potential for bias in the CPG dataset. In this memorandum, samples will be referred to as CPG samples or EPA samples for clarity. Significant split sample comparison findings are summarized below.

- Dioxins/Furans. The CPG and EPA analyses generally yielded similar results for polychlorinated dibenzodioxins/dibenzofurans (PCDD/F).
- Mercury. For the mercury and methylmercury split samples, there are indications that a sample aliquot for mercury may have been mislabeled and switched with another sample, based on review of the line plot and detected concentrations (see Figure 16).
- Other Metals. Of the 10 metals evaluated in the sediment data pairs, a statistically significant bias was exhibited for five metals. Neither dataset demonstrated a consistent bias.

- Total Organic Carbon (TOC). The CPG and EPA analyses generally yielded similar results.
- Polyaromatic Hydrocarbons (PAHs). Of the nine PAHs evaluated in the sediment data pairs, a statistically significant difference and low bias in CPG laboratory results was exhibited for four PAHs.
- Pesticides. A statistically significant difference and low bias in the CPG data was found in six of eight pesticide parameters evaluated in the paired sediment samples.
- Polychlorinated biphenyls (PCBs). The CPG and EPA analyses generally yielded similar results, particularly for the 2009 dataset. The 2010 EPA data trended lower than the CPG results for all eleven PCB congeners and total PCB results. There is no immediate apparent reason for the 2010 PCB EPA split sample concentration results being less than the CPG results. As additional split sample data are added to the dataset, these data may be identified as outlier results.

Oversight Program Summary

The field oversight program activities and observations are described in detail in the Field Oversight Reports, submitted under separate cover. Oversight was conducted in accordance with the Final Oversight Quality Assurance Project Plan (QAPP) for Biological Sampling, Community Surveys, Toxicity and Bioaccumulation Testing prepared by Malcolm Pirnie, Inc. and Battelle (August 2009) and associated approved QAPP modifications; and CDM's Quality Assurance Project Plan Final Addendum #4, Collection of Surface Sediment Samples Co-located with the Small Forage Fish Tissue Samples During Summer 2010 Benthic Invertebrate Community Survey.

The split sample programs consisted of:

- 10 sediment split samples collected in 2009
- 3 sediment split samples collected in 2010

Data Comparison Methodology

To examine the parent and split sample datasets for potential bias, CPG sample and EPA split sample data were plotted in three different formats for selected analytical parameters:

- A line plot of absolute concentration for the paired samples. The line plot provides insight on the relative magnitudes and patterns of concentrations measured by both analytical programs for the paired samples.
- A bivariate scatter plot of the detected concentrations. The bivariate scatter plot illustrates the relationship between the CPG sample and EPA split sample data, and in particular, highlights potential systematic bias if the points fall consistently above or below the 1:1 line.
- A line plot of percent difference. The percent difference (%D) is defined as the difference between the EPA and CPG sample concentrations, divided by the EPA sample concentration. Consequently, a negative %D indicates a CPG result that is higher than the EPA result, while a positive %D indicates a CPG result that is lower than the EPA result. This plot provides a visual indication of the extent of positive and negative differences between the two datasets. The red dashed lines on the plot correspond to 40%D and -67%D. These criteria correspond to 50% relative percent difference (RPD, the CPG's field duplicate acceptance criterion), converted to %D values. Note that RPD and %D are similar mathematical functions that allow a comparison of two values. %D is commonly used when one of the two values is known or accepted, whereas RPD is more commonly used when both values are uncertain (for example, for comparison of field duplicates).

In addition to the preparation of the above listed data comparison plots (Figures 1 through 49). The tests described below were also conducted for the CPG and EPA data pairs where a result was obtained above

the detection limit for both samples. The findings of these tests are summarized in Table 1 organized by analytical parameter.

- The average and standard error was calculated for the ratio of CPG result to EPA result (result greater than 1 indicates on average that the CPG's laboratory detected higher concentrations for a particular parameter; result less than 1 indicates that on average the EPA laboratory detected a higher concentration of a particular parameter).
- %D was compared to the criteria of 40%D and -67%D (equivalent to 50% RPD). The 50% RPD criteria are derived from the CPG's field duplicate evaluation criterion.
- The Wilcoxon Signed Rank test was used to calculate p-values. The p-value is an indicator of the presence of a bias or difference between the datasets. P-values less than 0.05 indicate a statistically significant difference between results.

Table 1 also contains the column "Overall Split Sample Comparison (Same or Different)," which presents the judgment of the data reviewers regarding the comparability of the split sample data. An opinion that the datasets were comparable (entry of "Same") was based on the following lines of evidence and associated criteria:

- Average ratio of CPG to EPA data within 0.7 to 1.3.
- %D within 40% to -67% for the majority of the sample pairs (one or two exceedances permitted if other lines of evidence indicated comparability of the CPG and EPA data).
- No statistical bias.

Where the cells in Table 1 contain multiple values, the value contained within the parentheses was calculated with outliers removed from the comparison. Below are some notable observations from Table 1:

PCDD/F

Split sample results were examined for selected PCDD/F congeners and homolog groups (*e.g.*, Total TCDD – see Figures 1 through 7 for the evaluated PCDD/Fs). With the exception of the OCDD and OCDF homologs, the CPG's laboratories detected higher concentrations on average. Of the 13 sample pairs, when exceedences were observed only one sample pair exceeded the %D criteria for any PCDD/F analyte evaluated. For 2,3,7,8-TCDD (Figure 3c), one sample pair exceeded the %D criteria, and in this case the CPG laboratory detected a higher concentration than the EPA laboratory. The p-value indicated the presence of a systematic bias for 1,2,3,4,6,7,8-HpCDD and OCDF. This bias is evident on Figures 1a and 6a respectively; in the first case the CPG consistently detected higher concentrations than the EPA and in the second case the CPG consistently detected lower concentrations. In general, the PCDD/F results were comparable between the CPG and EPA laboratories.

Metals

Based on the calculated p-values and evaluation of the plots; the CPG's laboratories consistently detected lower concentrations of arsenic (Figure 8a) and nickel (Figure 17a) and consistently higher concentrations of iron (Figure 15a). The mercury comparison is of interest because it appears that split samples LPRT11C and LPRT11E may have been mislabeled (Figure 16a). Five of ten samples exceed the %D criteria for mercury and a CPG to EPA concentration ratio of 1.6. It is recommended that further investigation be conducted to evaluate the possibility that the samples were mislabeled.

PAHs

For the PAH parameters, benzo(a)pyrene, chrysene, fluoranthene, naphthalene, and pyrene, the majority of the split sample pairs plotted below the 1:1 line on the bivariate plots, indicating the CPG consistently detected lower concentrations than the EPA. For benzo(a)pyrene (Figure 22c), five of the

split sample pairs exceeded the %D criteria. In general, the p-value calculated for these parameters indicated the presence of a low bias in the CPG PAH results.

Pesticides

Review of the pesticide analyses showed that the average ratio of CPG to EPA laboratory detections was generally less than one, indicating the CPG consistently detected lower concentrations than the EPA. Each parameter evaluated had at least one and up to eight sample pairs outside the %D criteria. In general, the p-value calculated for these parameters indicated the presence of a low bias in the CPG pesticide results.

TOC

Two of the TOC analysis sample pairs were outside the %D criteria. The average ration result, greater than 0.95, and calculated p-value indicate that the TOC data are comparable.

PCBs

A data evaluation was conducted for total PCB and 11 PCB congeners. The split 2009 sample pairs met the %D criteria with the exception of one pair for BZ 126. For BZ 169, the EPA and the CPG laboratory reported non-detects; therefore, the %D criteria and p-value could not be evaluated. The p-values indicated that the datasets are comparable but the 2010 PCB %D results (samples LPRC05A, LPRC07D and LPRC15A) consistently exceeded criteria. This disparity is evident on Figures 38a through 49a where EPA samples LPRC05A, LPRC07D and LPRC15A are consistently and significantly below the CPG results. The 2010 data disparity is also evidenced in the high average ratios for the PCB data. Since there are only 13 split sample pairs in this dataset, the 2010 data did not get identified as outliers. This may change as the dataset increases.

Attachments

Comments on the September 2, 2011 CPG Draft 2009 and 2010 Sediment Chemistry Data for the Lower Passaic River Study Area

Table 1: 2009 and 2010 Lower Passaic River Sediment Split Sample Comparison Summary Table

2009 through 2010 Statistical Plot of Sediment Concentrations Figures

- Figures 1 through 7: Statistical Plots of Sediment Dioxin/Furan Concentrations
- Figures 8 through 18: Statistical Plots of Sediment Metal Concentrations
- Figure 19: Statistical Plots of Sediment Methyl Mercury Concentrations
- Figures 20 through 28 Statistical Plots of Sediment Polycyclic Aromatic Hydrocarbons (PAHs) Concentrations
- Figures 28 through 36: Statistical Plots of Sediment Pesticide Concentrations
- Figure 37: Statistical Plots of Sediment Total Organic Carbon (TOC) Concentrations
- Figures 38 through 49: Statistical Plots of Sediment Polychlorinated biphenyls (PCBs) Concentrations

Comments on the September 2, 2011 CPG Draft 2009 and 2010 Sediment Chemistry Data for the
Lower Passaic River Study Area

COMMENTS

DRAFT 2009 AND 2010 SEDIMENT CHEMISTRY DATA FOR THE LOWER PASSAIC RIVER STUDY AREA
DATED SEPTEMBER 2, 2011

<u>No.</u>	<u>Page No.</u>	<u>Specific Comment</u>
1	Page 1, First paragraph, first sentence	The text states that the data described in the report were collected in fall of 2009 and spring of 2010. The 2010 sampling event occurred in August. Please revise to summer.
2	Pages 2 and 3, Table 1-1	Under the Column titled “QAPP/Sampling Plan Citation” the AECOM’s QAPPs for RM 10.9 and small-volume CWCM are listed as in preparation. Please revise with the correct dates as both the draft and final RM 10.9 and small-volume CWCM QAPPs have been completed. In addition, please revise in Section 6 References.
3	Page 4, First paragraph, first sentence	Please revise text to read “summer 2010” not spring 2010.
4	Page 24, Table 4-2	Under the Column titled “Mean” please adjust the column width to allow room for 5 digit values (see aluminum and iron).
5	Page 83, Second paragraph	Based on the Table 4-9, PCDDs/PCDFs had detection frequencies ranging from 96% to 100%. The text on page 83 states 95% to 100%. Please revise accordingly.
6	Page 116, Third sentence	The text states that 2-butanone was detected in 95.5% of the samples; however, Table 4-12 states 100%. In addition, the text states that 2-butanone was the most frequently detected VOC in the 2009 and 2010 datasets; however, acetone and methyl acetate are listed in Table 4-12 as being detected in 100% of the 2010 samples. Please revise accordingly.
7	Page 117, Section 4.10 TPH	There is no discussion on TPH results as seen in other sections. For example, there is no mention of the most commonly occurring compounds, frequency of detection, and concentration ranges. Please add a discussion of the TPH results to this section.
8	Page 121, Section 4.11	The discussion is limited only to ammonia and TKN. Phosphorus and sulfide was detected in all samples during both events, and cyanide was detected in 82% of the samples in 2010. It is suggested that these data trends also be included in the discussion.

2009 through 2010 Sediment Split Samples Comparison Summary Table

Table 1-2009 and 2010 Lower Passaic River Sediment Split Samples Comparison Summary Table

Parameter	Number of Split Sample Pairs	Number of Split Sample Pairs where Detected Concentrations were Reported by USEPA and CPG	Average Ratio of CPG to USEPA with Standard Error (for detected pairs)	Comparison to Percent Difference Criteria (for detected pairs)	P±Value (for detected pairs)	Presence of Statistical Bias (Yes or No)	Overall Split Sample Comparison (Same or Different)
Dioxin/Furans							
1,2,3,4,6,7,8-HxCDD	13	13	1.2 ± 0.045	Within Range	0.001	Yes	Same
1,2,3,4,6,7,8-HxCDF	13	13	1.03 ± 0.081	Outside of Range for one sample	0.946	No	Same
2,3,7,8-TCDD	13	11	1.1 ± 0.11	Outside of Range for one sample	0.593	No	Same
2,3,7,8-TCDF	13	13	1.2 ± 0.044	Within Range	0.017	Yes	Same
OCDD	13	13	1.02 ± 0.044	Within Range	0.787	No	Same
OCDF	13	13	0.8 ± 0.071	Outside of Range for one sample	0.01	Yes	Same
Total TCDD	13	13	1.1 ± 0.085	Outside of Range for one sample	0.588	No	Same
Metals							
Arsenic	13	13	0.79 ± 0.054	Outside of Range for three samples	0.005	Yes	Different
Barium	13	11	1.1 ± 0.11	Outside of Range for two samples	0.915	No	Same
Cadmium	13	13	1.03 ± 0.072	Outside of Range for one sample	0.289	No	Same
Chromium	13	13	1.1 ± 0.072	Within Range	0.244	No	Same
Cobalt	13	13	0.88 ± 0.047	Within Range	0.061	No	Same
Copper	13	13	1.03 ± 0.063	Outside of Range for one sample	0.414	No	Same
Iron	13	13	1.2 ± 0.027	Within Range	0.0001	Yes	Same
Lead	13	13	1.1 ± 0.029	Within Range	0.017	Yes	Same
Mercury	13	13	1.6 ± 0.35	Outside of Range for five samples	0.04	Yes	Different
Nickel	13	13	0.78 ± 0.048	Outside of Range for two samples	0.001	Yes	Different
Zinc	13	13	1.2 ± 0.064	Outside of Range for one sample	0.009	Yes	Same
Methyl Mercury	13	12	1.2 ± 0.368	Outside of Range for four samples	0.47	No	Same
Polycyclic aromatic hydrocarbons (PAHs)							
Anthracene	13	13	1 ± 0.053	Within Range	0.893	No	Same
Benzo[a]anthracene	13	13	1.2 ± 0.16	Outside of Range for one sample	0.685	No	Same
Benzo[a]pyrene	13	13	0.89 ± 0.17	Outside of Range for five samples	0.031	Yes	Different
Chrysene	13	13	0.92 ± 0.10	Outside of Range for three samples	0.034	Yes	Different
Fluoranthene	13	13	1 ± 0.14	Outside of Range for one samples	0.065	No	Same
Indeno[1,2,3-cd]pyrene	13	13	1.2 ± 0.24	Outside of Range for two samples	0.685	No	Same
Naphthalene	13	12	0.72 ± 0.057	Outside of Range for three samples	0.005	Yes	Different
Phenanthrene	13	13	1 ± 0.17	Outside of Range for three samples	0.542	No	Same
Pyrene	13	13	0.82 ± 0.10	Outside of Range for four samples	0.008	Yes	Different
Pesticides							
2,4'-DDD	13	13	0.85 ± 0.082	Outside of Range for two samples	0.021	Yes	Different
2,4'-DDE	13	11	0.6 ± 0.0748	Outside of Range for five samples	0.001	Yes	Different
2,4'-DDT	13	12 (11)	1.1 ± 0.27 (1.19 ± 0.27)	Outside of Range for six samples	0.38	No	Different
4,4'-DDD	13	13 (11)	0.70 ± 0.094 (0.79 ± 0.083)	Outside of Range for four samples	0.001	Yes	Different
4,4'-DDE	13	13	0.63 ± 0.074	Outside of Range for seven samples	0.001	Yes	Different
4,4'-DDT	13	12 (10)	2.6 ± 1.69 (3.3 ± 2.17)	Outside of Range for eight samples	0.718	No	Different
Dieldrin	13	13	0.67 ± 0.049	Outside of Range for four samples	0.0001	Yes	Different
gamma-Chlordane	13	13	0.76 ± 0.062	Outside of Range for three samples	0.002	Yes	Different
Total Organic Carbon (TOC)							
TOC	13	13 (12)	0.961 ± 0.12 (1.0 ± 0.0996)	Outside of Range for two samples	0.349	No	Same
Polychlorinated biphenyls (PCBs)							
Total PCB	13	13	0.94 ± 0.114	Outside of Range for three sample	0.588	No	Same 2009 Different 2010
3,3',4,4'-Tetrachlorobiphenyl (BZ 77)	13	13	1.63 ± 0.595	Outside of Range for two samples	0.414	No	Same 2009 Different 2010
3,4,4',5-Tetrachlorobiphenyl (BZ 81)	13	6	1.1 ± 0.13	Outside of Range for one sample	0.875	No	Same 2009 Different 2010
2,3,3',4,4'-Pentachlorobiphenyl (BZ 105)	13	13	3.3 ± 1.8	Outside of Range for three samples	0.542	No	Same 2009 Different 2010
2,3,4,4',5-Pentachlorobiphenyl (BZ 114)	13	13	3.6 ± 2.2	Outside of Range for three samples	0.685	No	Same 2009 Different 2010
2,3',4,4',5-Pentachlorobiphenyl (BZ 118)	13	13	3.1 ± 1.8	Outside of Range for three samples	1	No	Same 2009 Different 2010
2,3',4,4',5'-Pentachlorobiphenyl (BZ 123)	13	13	3.1 ± 1.6	Outside of Range for three samples	0.787	No	Same 2009 Different 2010
3,3',4,4',5-Pentachlorobiphenyl (BZ 126)	13	8	1.2 ± 0.076	Within Range	0.55	No	Same 2009 Different 2010
2,3,3',4,4',5-Hexachlorobiphenyl + 2,3,3',4,4',5'-Hexachlorobiphenyl (BZ 156 + BZ 157)	13	13	2.8 ± 1.6	Outside of Range for three samples	0.946	No	Same 2009 Different 2010
2,3',4,4',5,5'-Hexachlorobiphenyl (BZ 167)	13	13	2.7 ± 1.4	Outside of Range for three samples	0.839	No	Same 2009 Different 2010
3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169)	13	0	NA	NA	NA	NA	Inconclusive
2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ 189)	13	12	1.5 ± 0.49	Outside of Range for two samples	0.97	No	Same 2009 Different 2010

Notes:

1) The average and standard error between the parentheses excludes the outlier samples.

2) p-Values and statistical significance were tested for alpha level of 0.05.

3) NA: Indicates that sample was not evaluated for statistical bias due to the sample size.

2009 through 2010 Statistical Plot of Sediment Concentrations Figures

Figure 1a: Line Plot of 1,2,3,4,6,7,8-HpCDD Concentrations

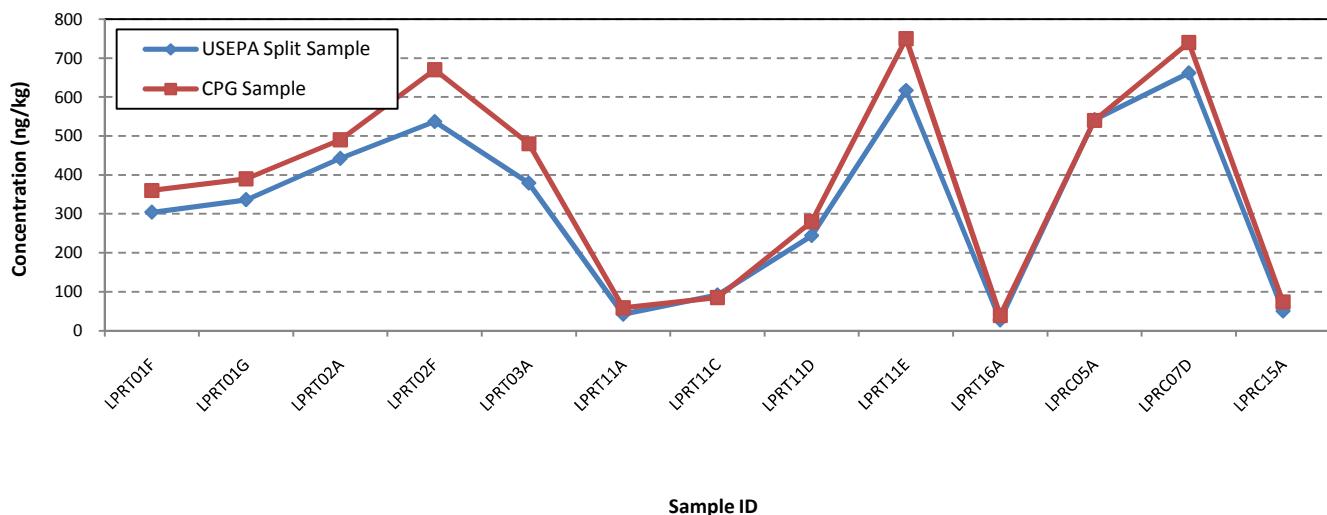


Figure 1b: Bivariate Plot of 1,2,3,4,6,7,8-HpCDD Concentrations

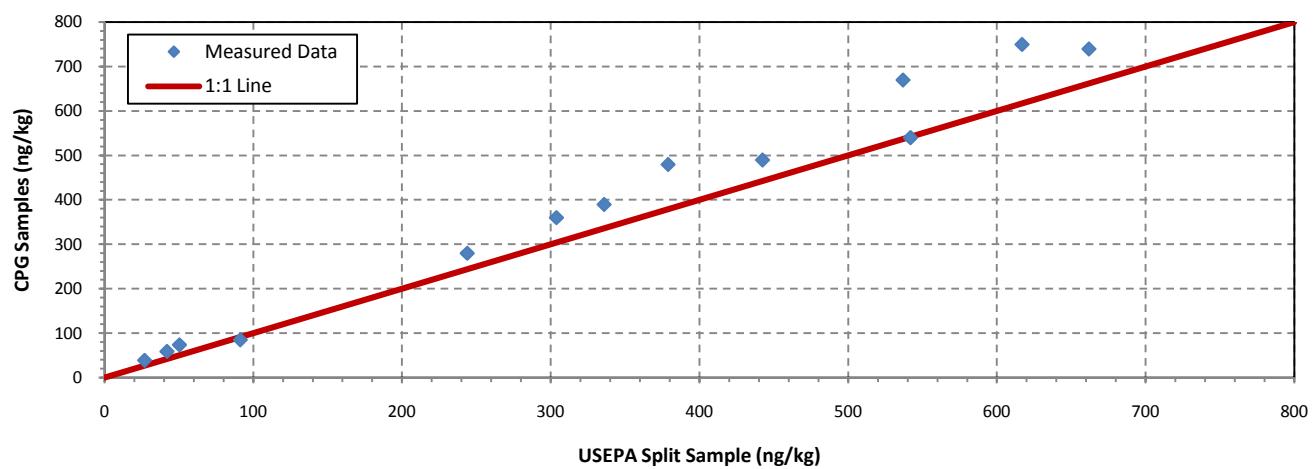


Figure 1c: Line Plot of 1,2,3,4,6,7,8-HpCDD Percent Differences when USEPA and CPG both had Detected Concentrations

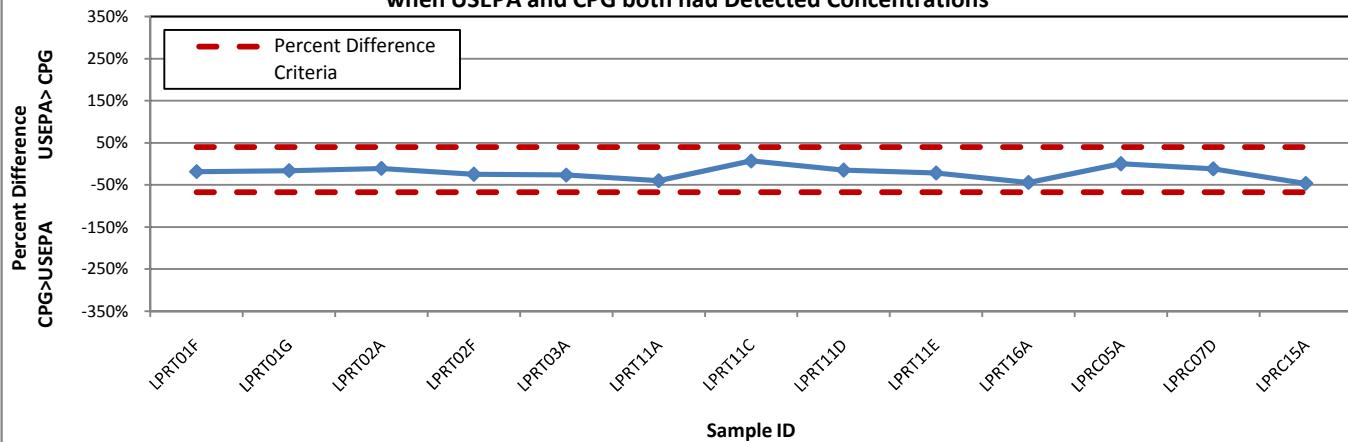


Figure 2a: Line Plot of 1,2,3,4,6,7,8-HpCDF Concentrations

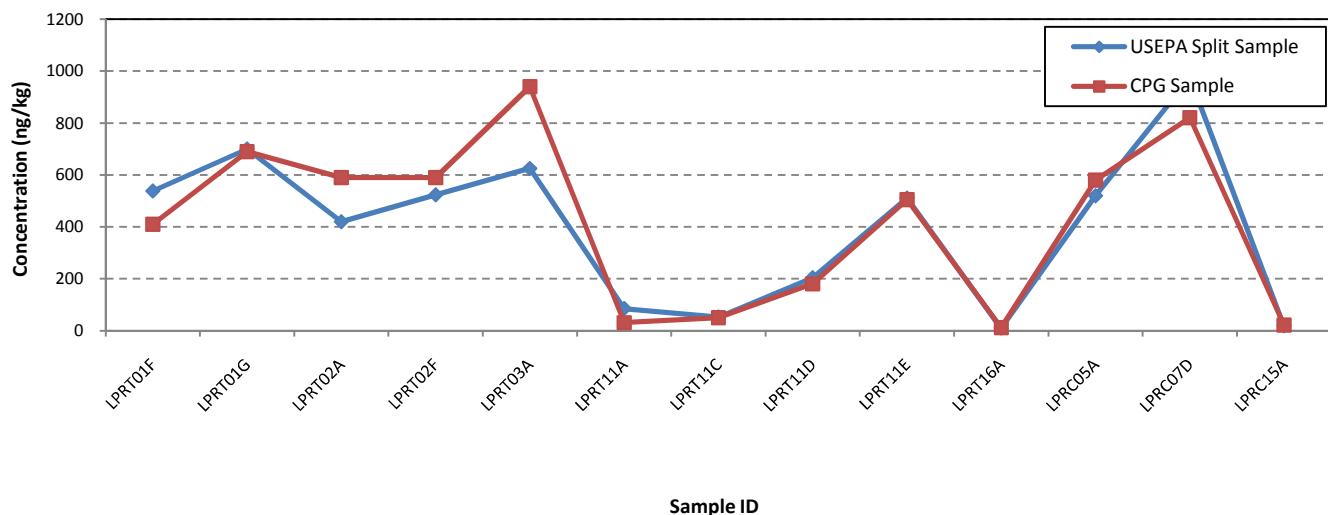


Figure 2b: Bivariate Plot of 1,2,3,4,6,7,8-HpCDF Concentrations

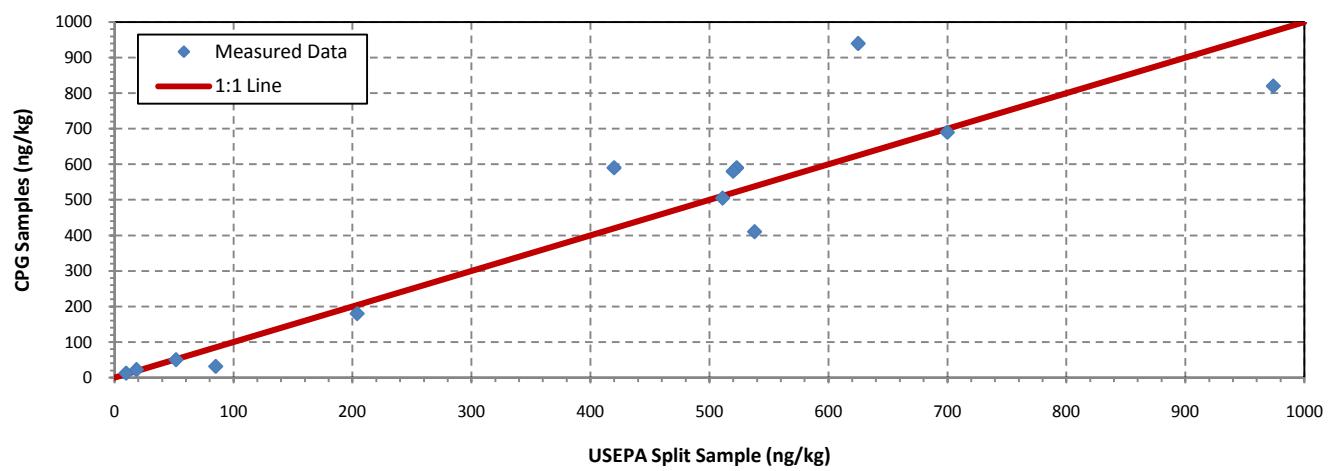


Figure 2c: Line Plot of 1,2,3,4,6,7,8-HpCDF Percent Differences when USEPA and CPG both had Detected Concentrations

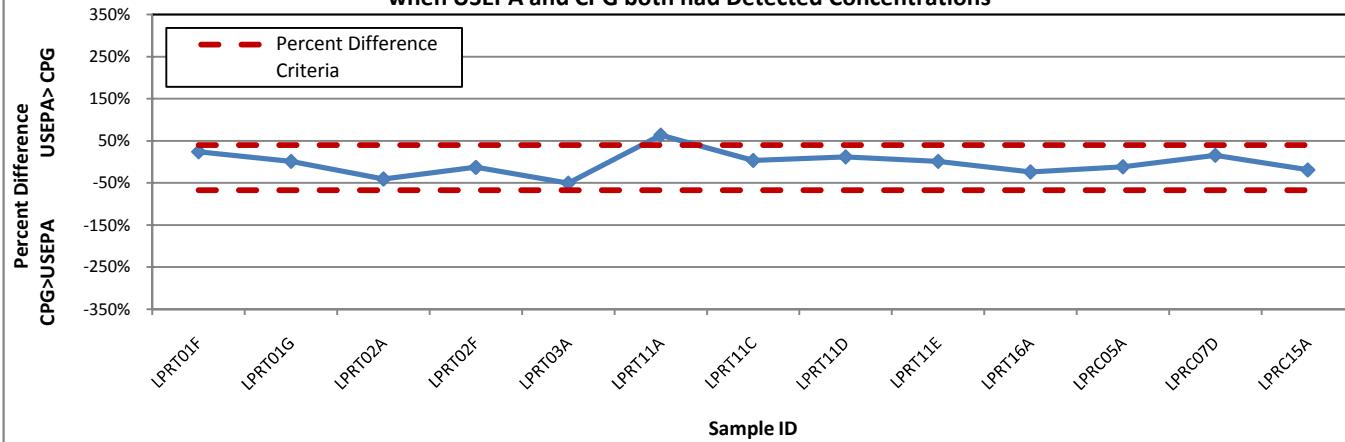


Figure 3a: Line Plot of 2,3,7,8-TCDD Concentrations

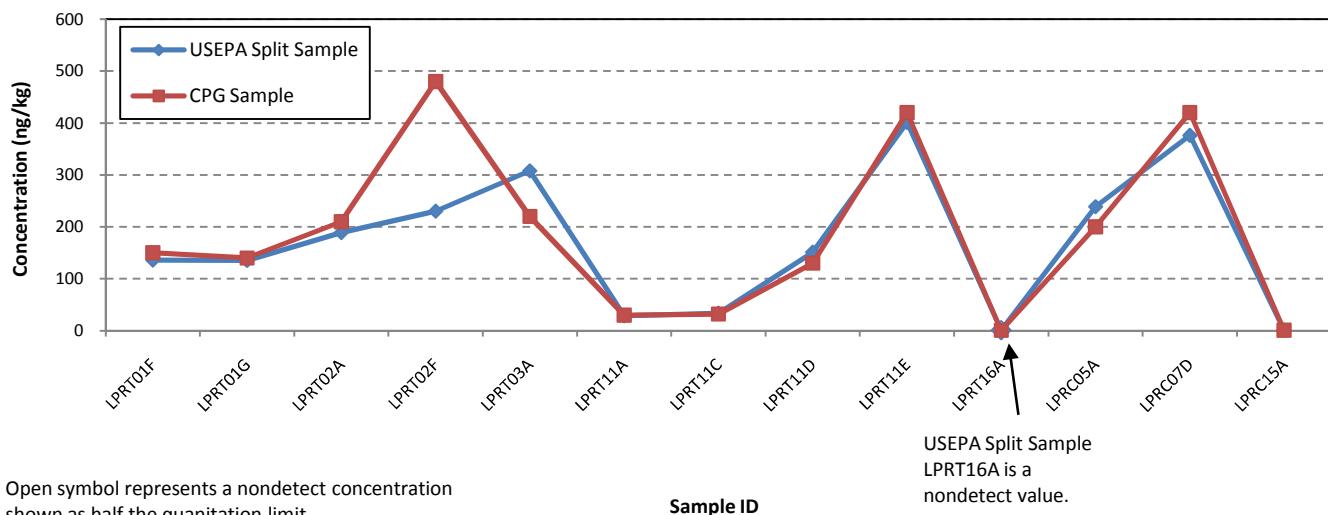


Figure 3b: Bivariate Plot of 2,3,7,8-TCDD Concentrations

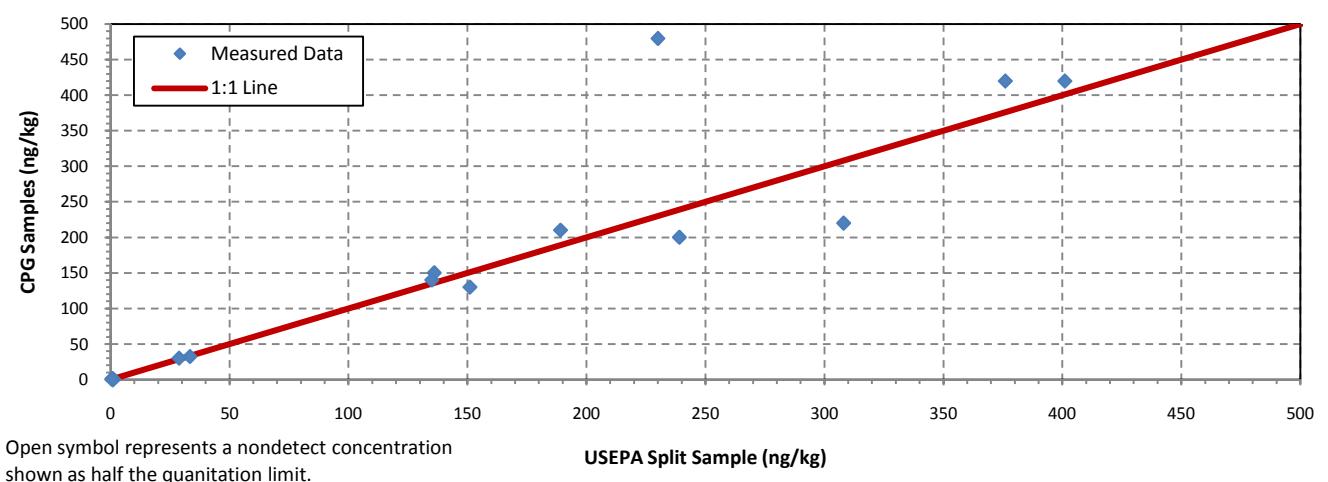


Figure 3c: Line Plot of 2,3,7,8-TCDD Percent Differences when USEPA and CPG both had Detected Concentrations

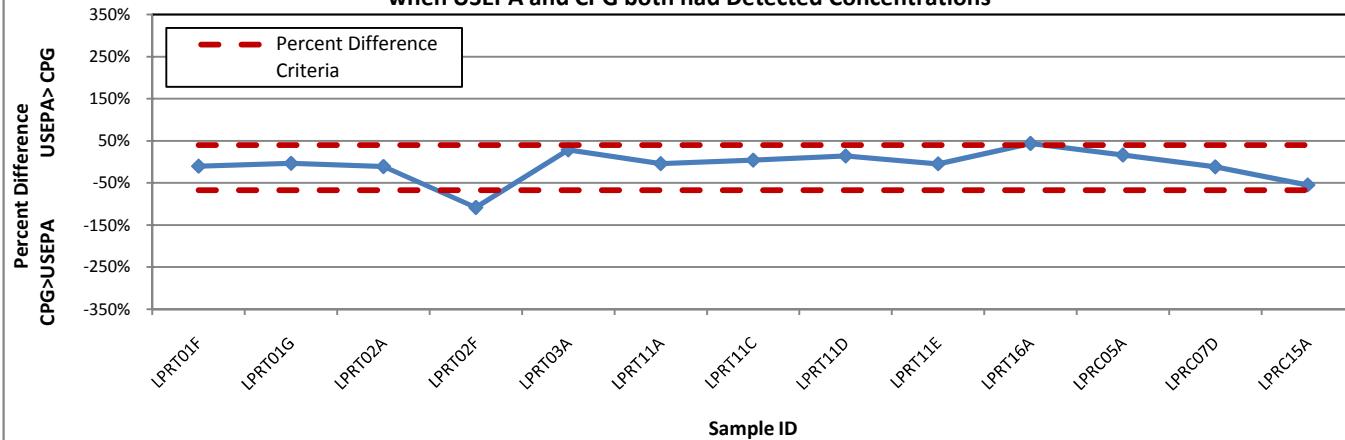


Figure 4a: Line Plot of 2,3,7,8-TCDF Concentrations

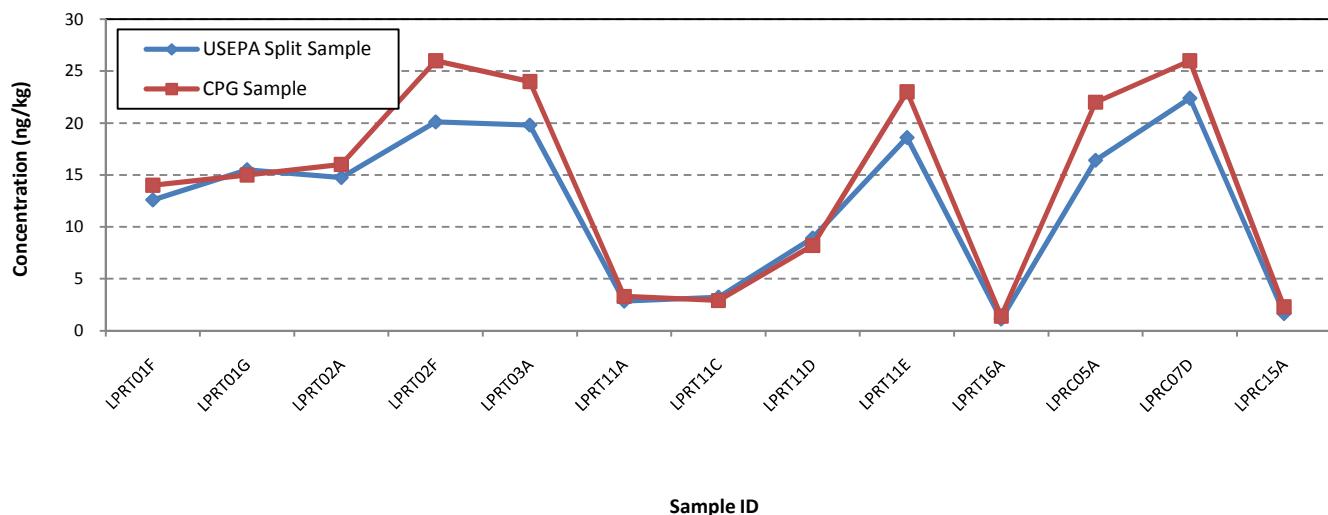


Figure 4b: Bivariate Plot of 2,3,7,8-TCDF Concentrations

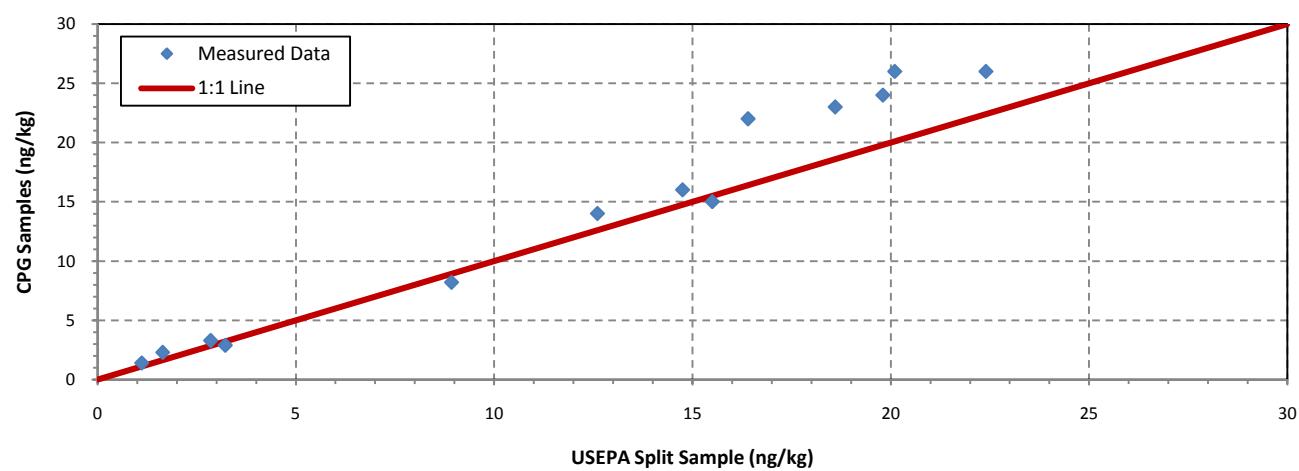


Figure 4c: Line Plot of 2,3,7,8-TCDF Percent Differences when USEPA and CPG both had Detected Concentrations

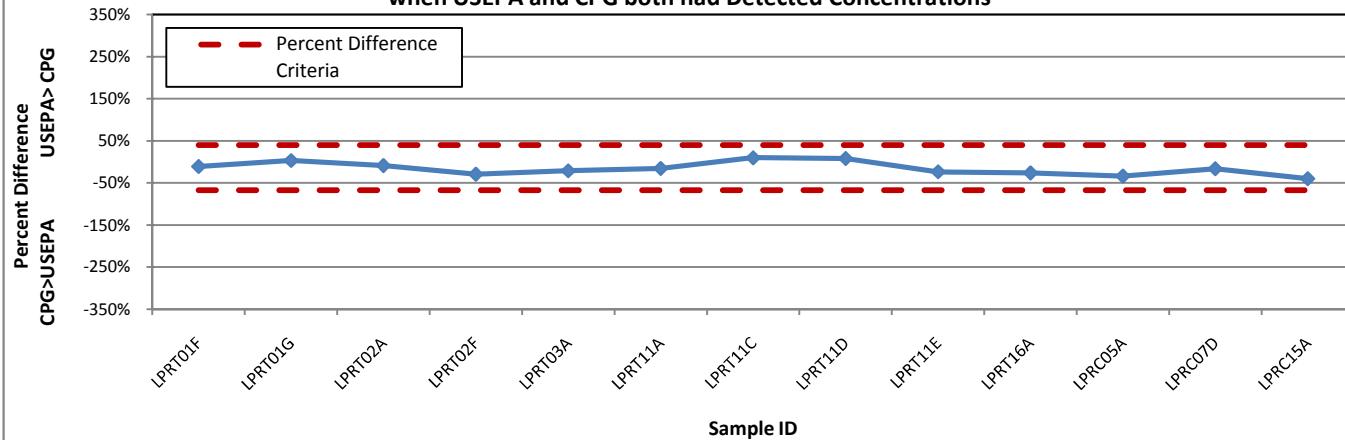


Figure 5a: Line Plot of OCDD Concentrations

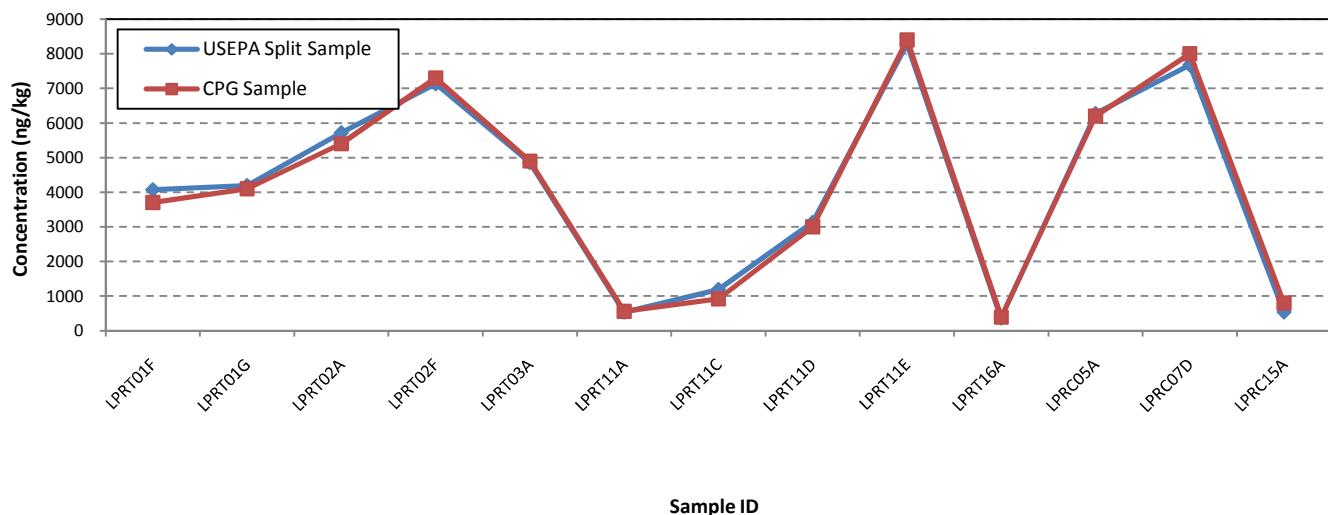


Figure 5b: Bivariate Plot of OCDD Concentrations

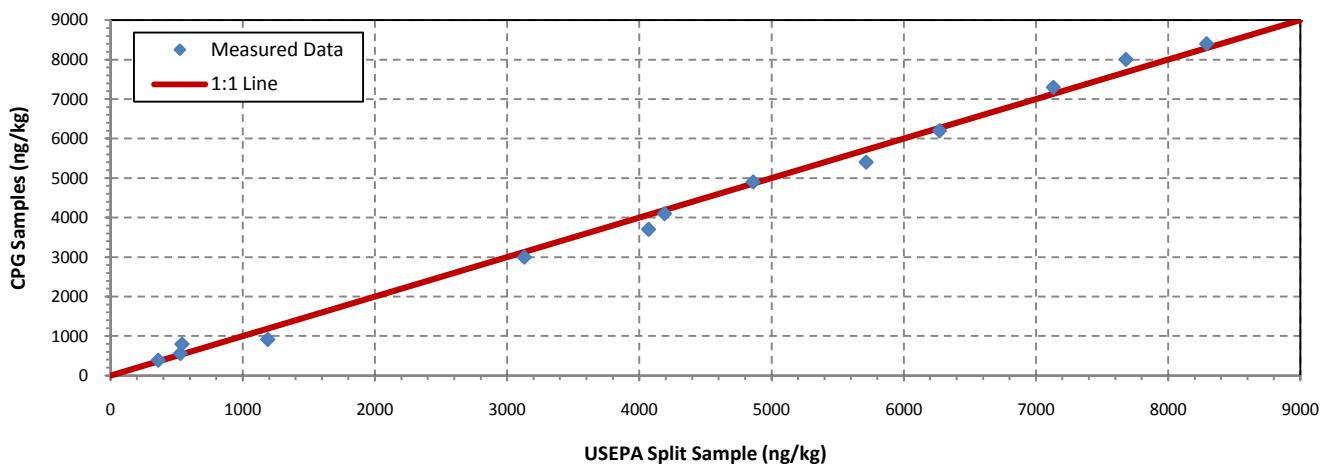


Figure 5c: Line Plot of OCDD Percent Differences when USEPA and CPG both had Detected Concentrations

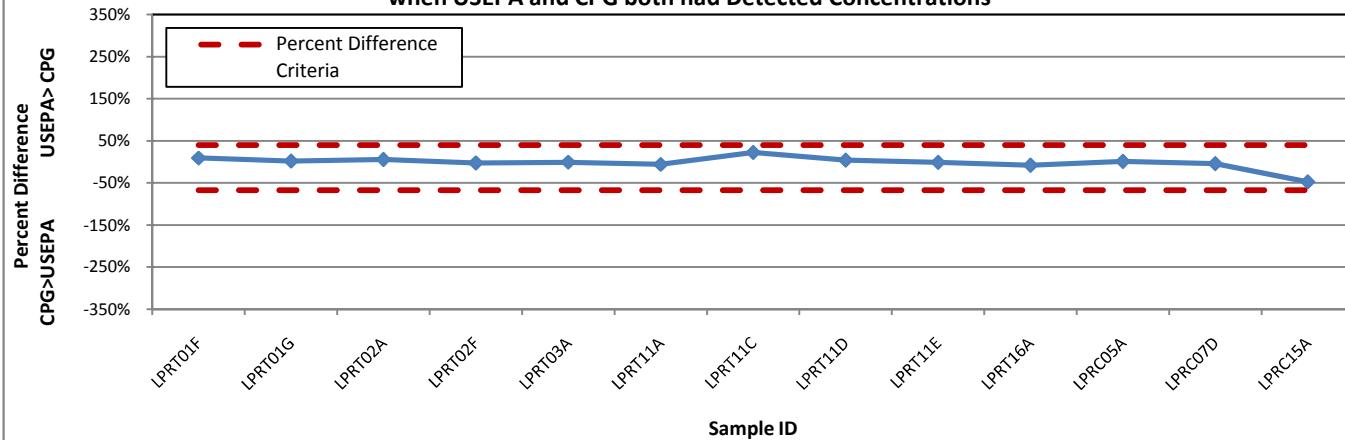


Figure 6a: Line Plot of OCDF Concentrations

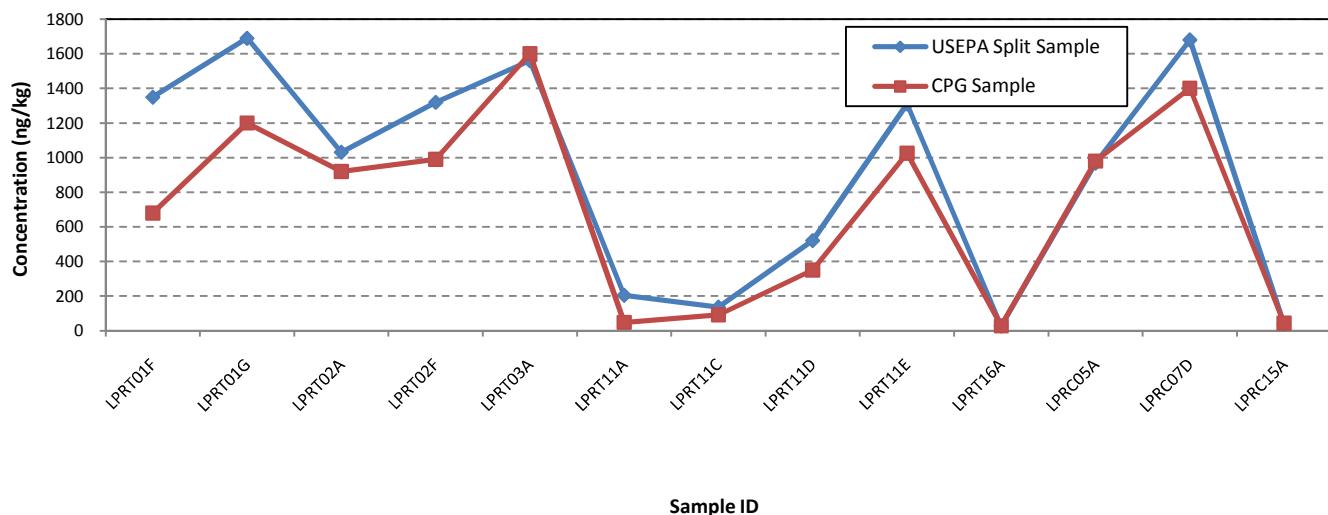


Figure 6b: Bivariate Plot of OCDF Concentrations

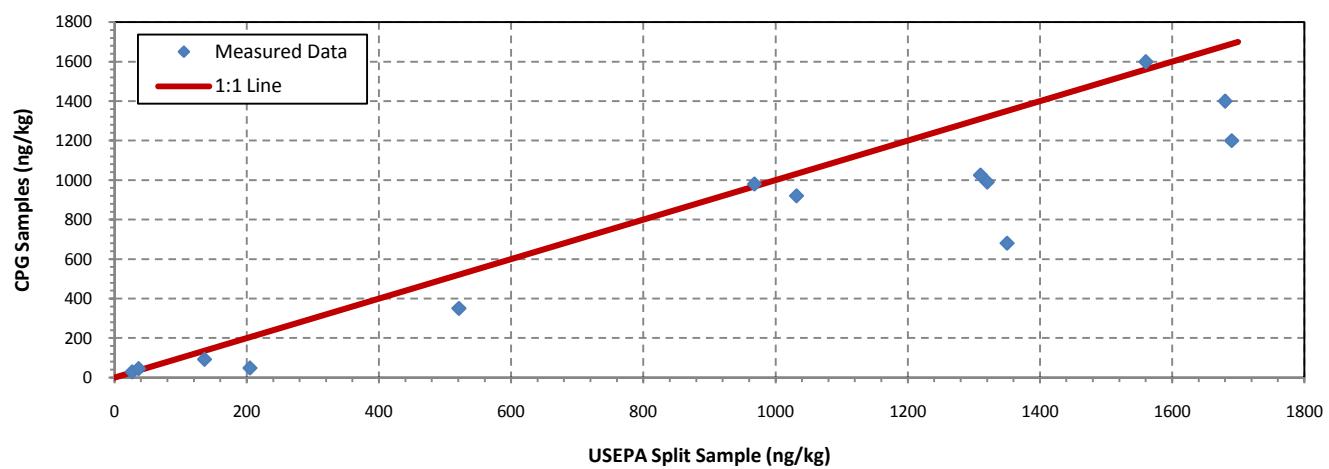


Figure 6c: Line Plot of OCDF Percent Differences when USEPA and CPG both had Detected Concentrations

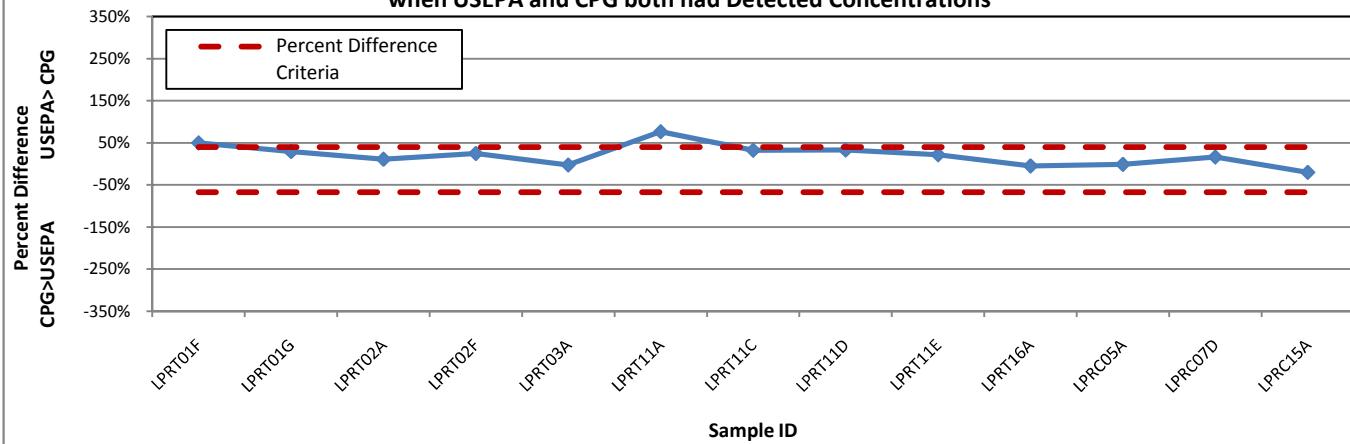


Figure 7a: Line Plot of Total TCDD Concentrations

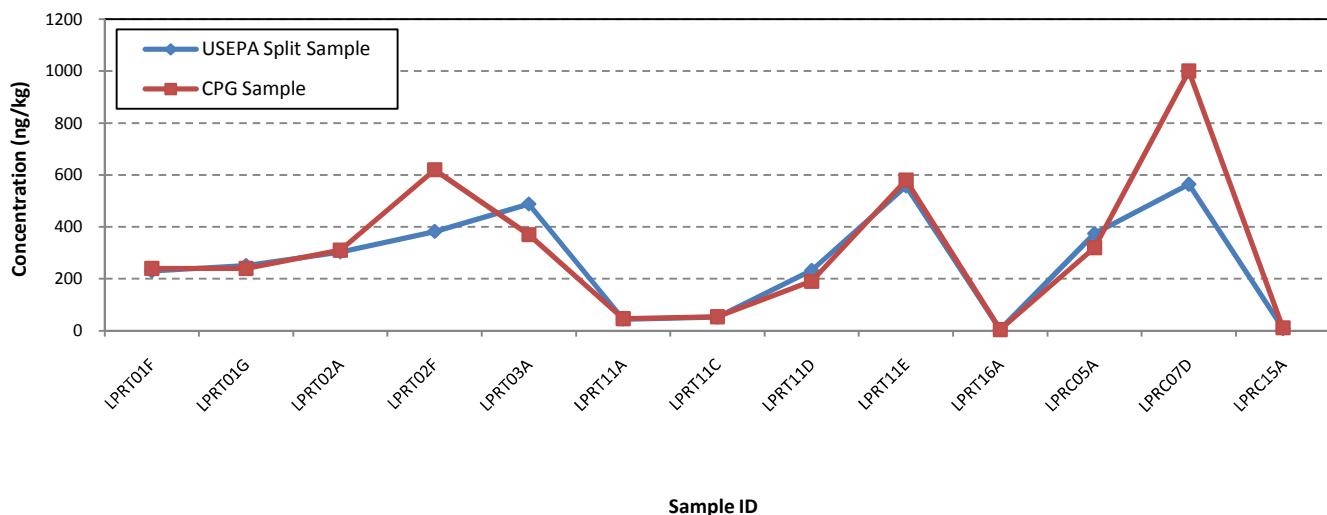


Figure 7b: Bivariate Plot of Total TCDD Concentrations

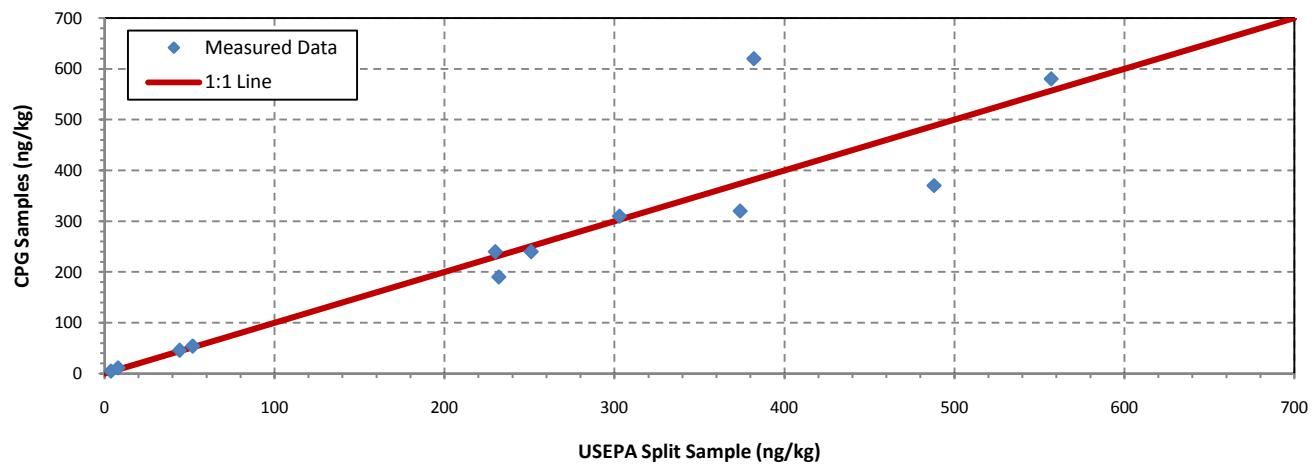


Figure 7c: Line Plot of Total TCDD Percent Differences when USEPA and CPG both had Detected Concentrations

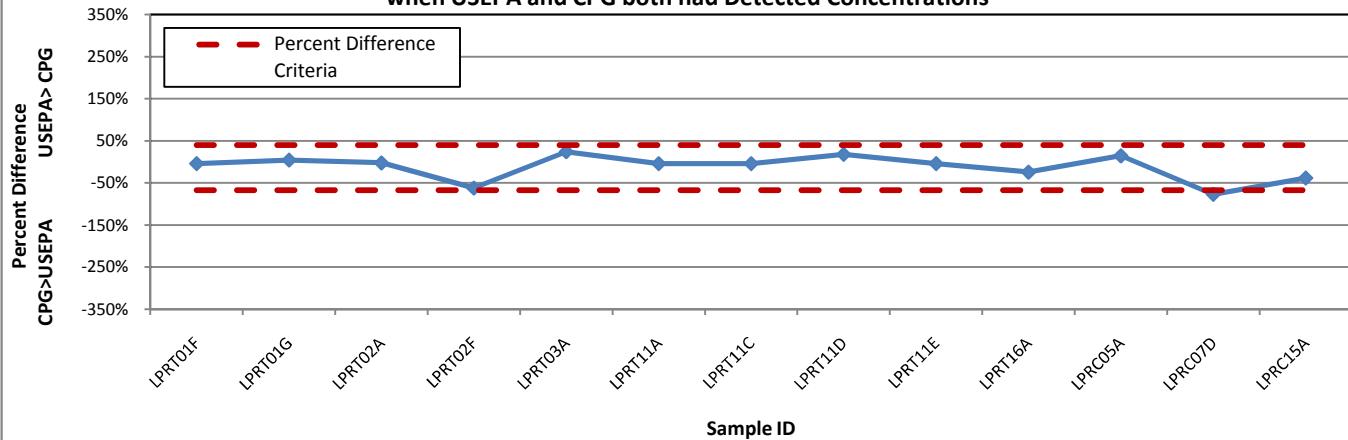


Figure 8a: Line Plot of Arsenic Concentrations

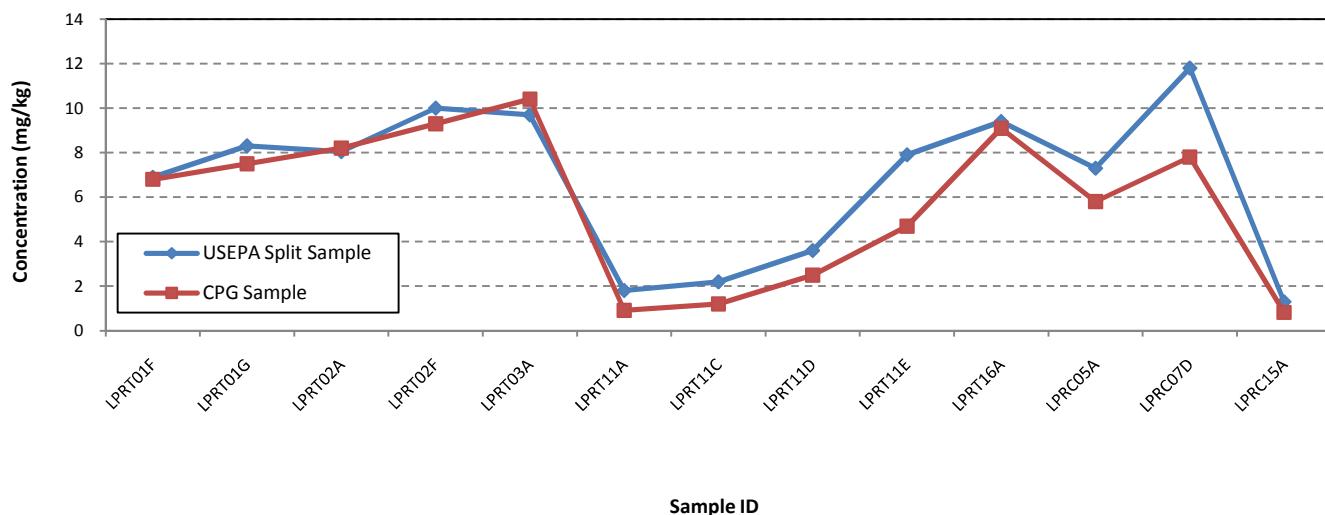


Figure 8b: Bivariate Plot of Arsenic Concentrations

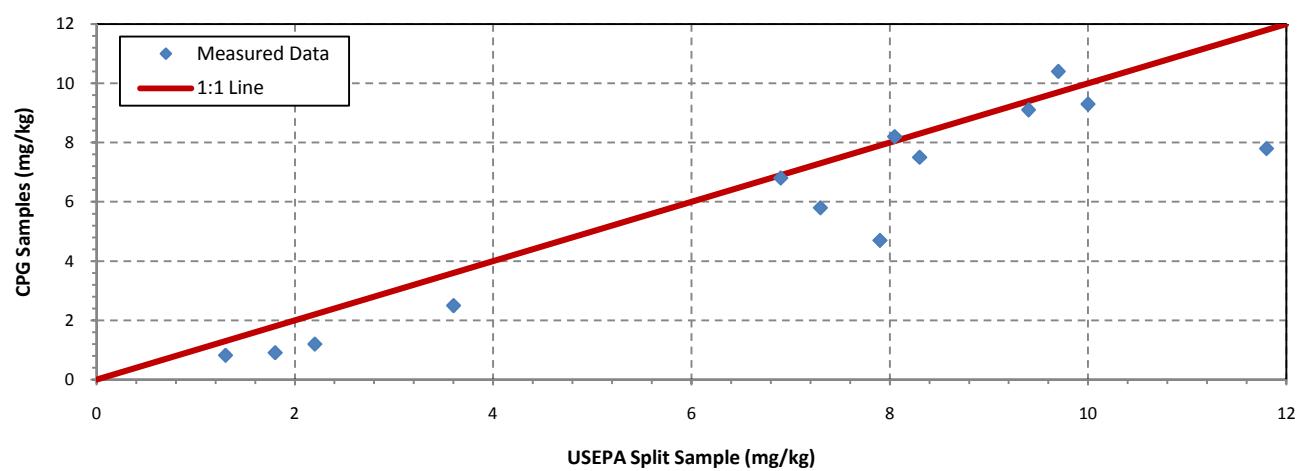


Figure 8c: Line Plot of Arsenic Percent Differences when USEPA and CPG both had Detected Concentrations

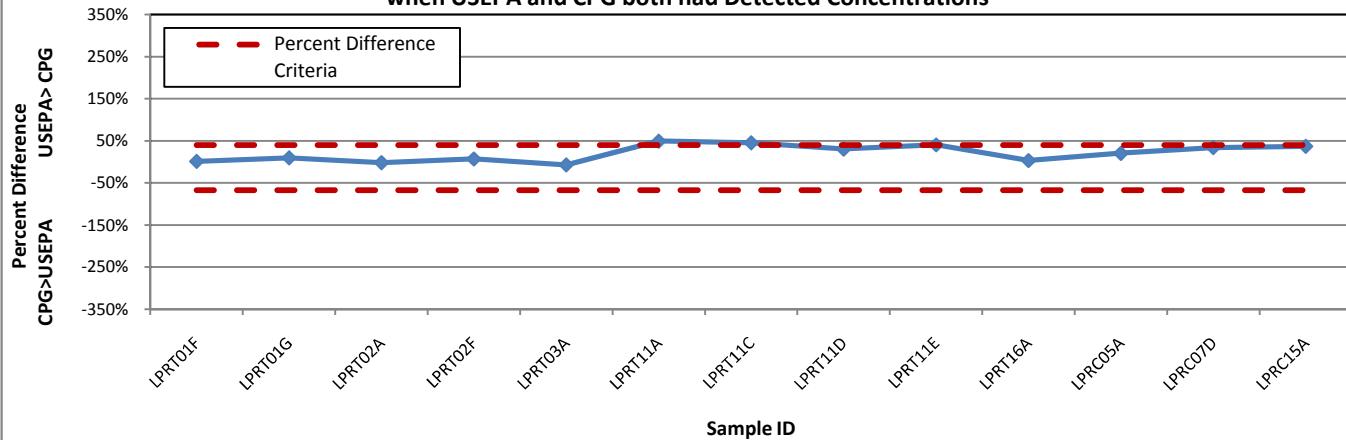


Figure 9a: Line Plot of Barium Concentrations

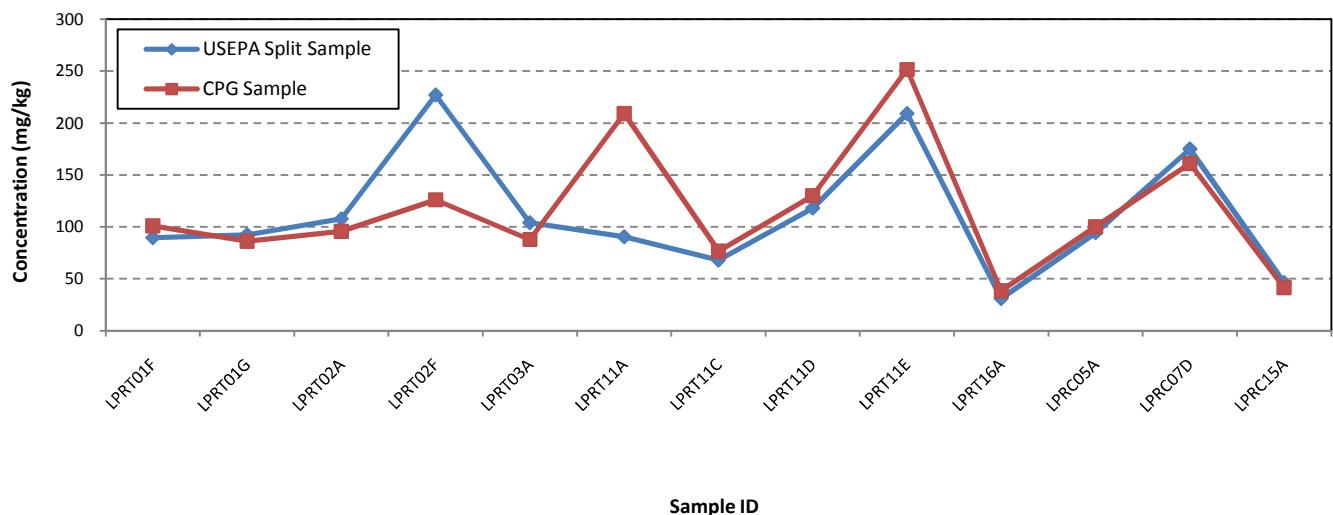


Figure 9b: Bivariate Plot of Barium Concentrations

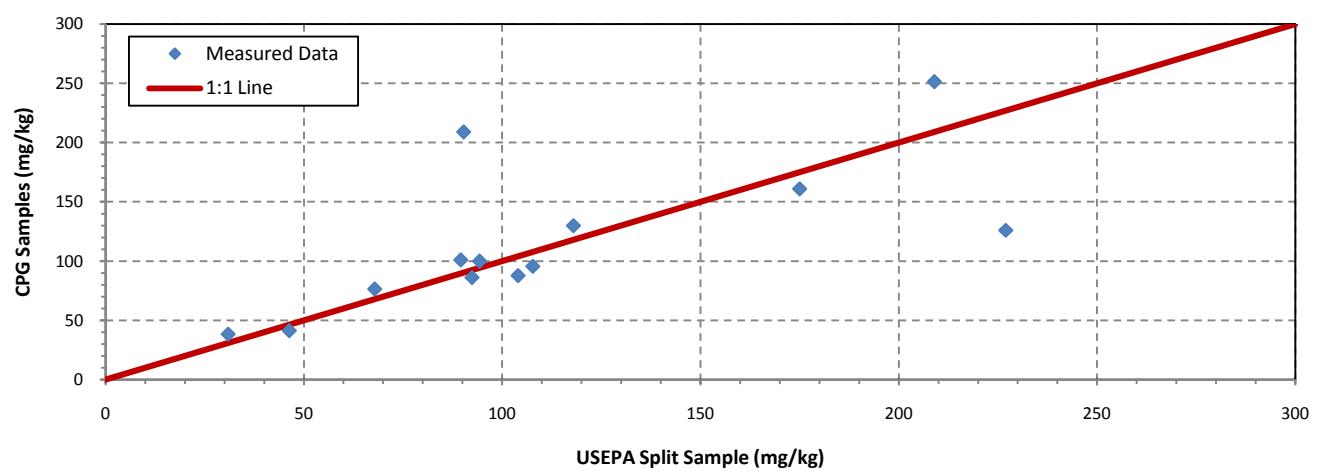


Figure 9c: Line Plot of Barium Percent Differences when USEPA and CPG both had Detected Concentrations

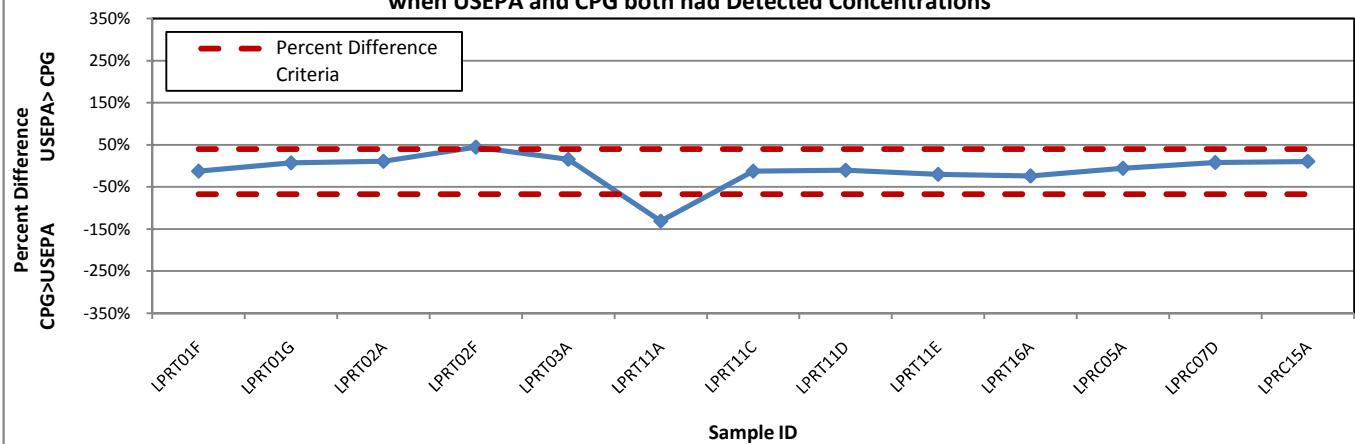


Figure 10a: Line Plot of Cadmium Concentrations

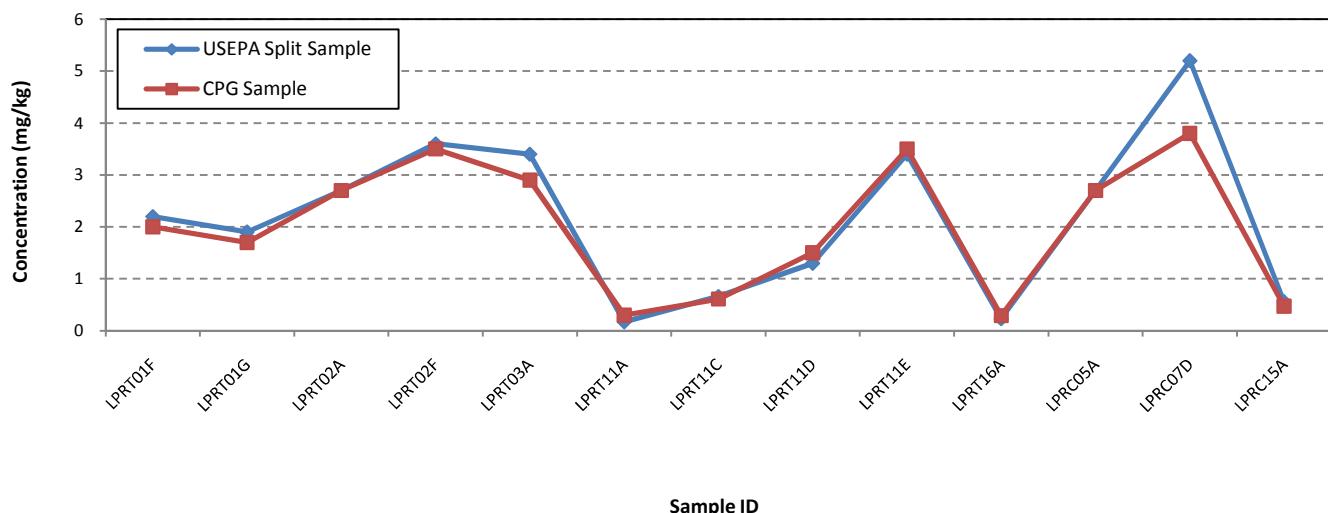


Figure 10b: Bivariate Plot of Cadmium Concentrations

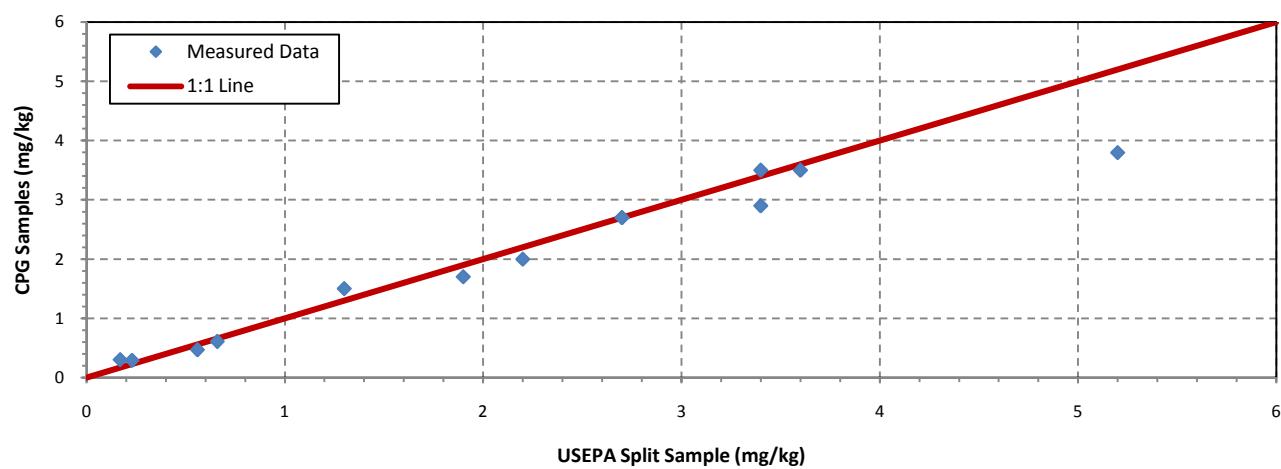


Figure 10c: Line Plot of Cadmium Percent Differences when USEPA and CPG both had Detected Concentrations

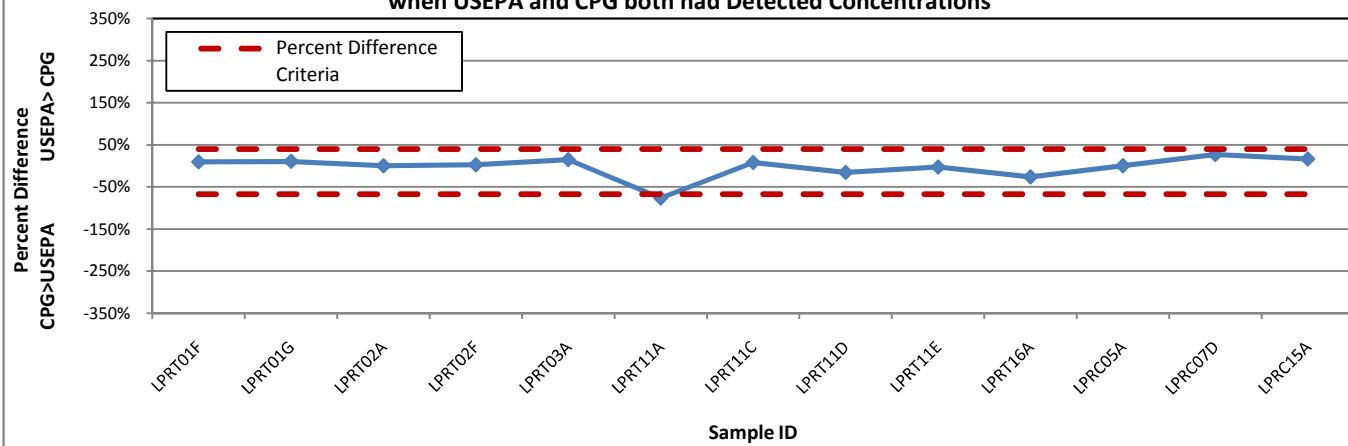


Figure 11a: Line Plot of Chromium Concentrations

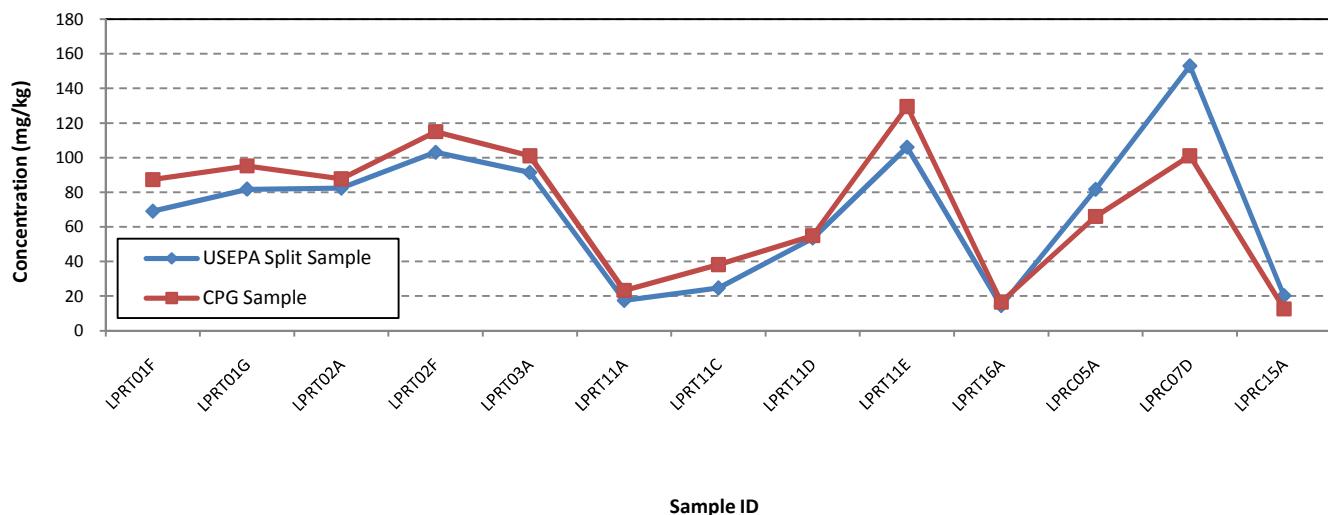


Figure 11b: Bivariate Plot of Chromium Concentrations

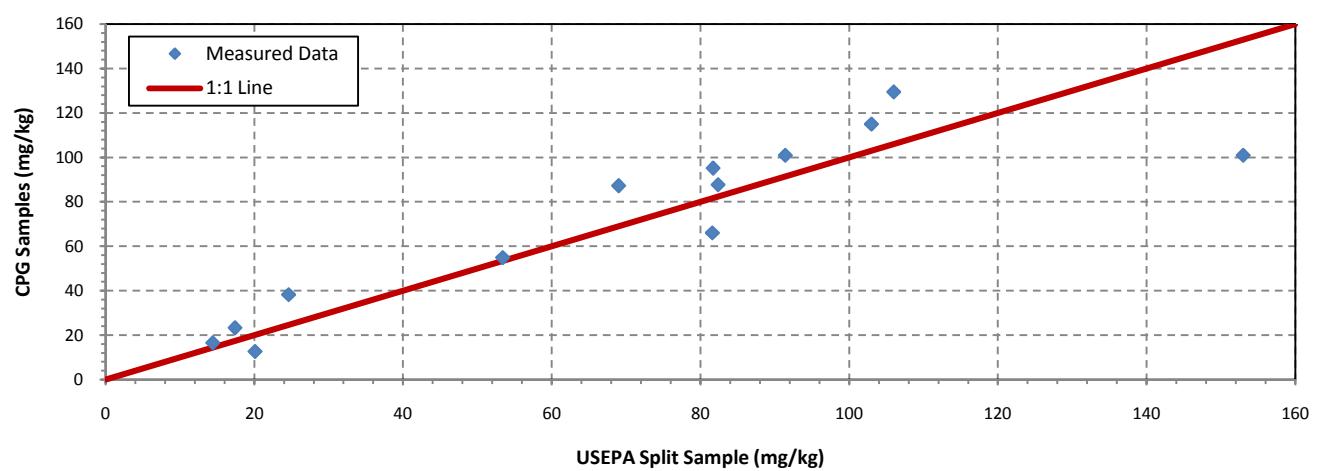


Figure 11c: Line Plot of Chromium Percent Differences when USEPA and CPG both had Detected Concentrations

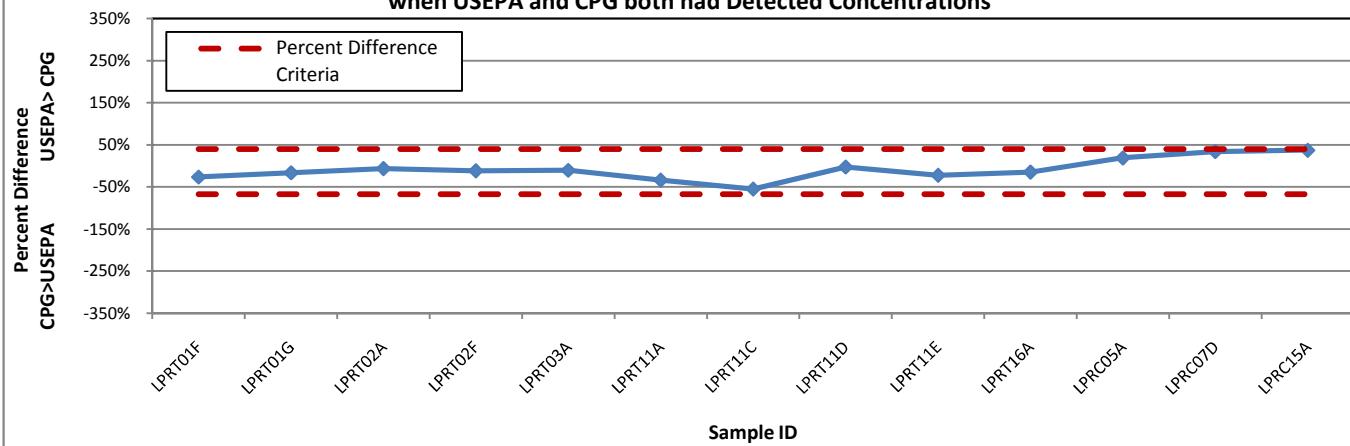


Figure 12a: Line Plot of Cobalt Concentrations

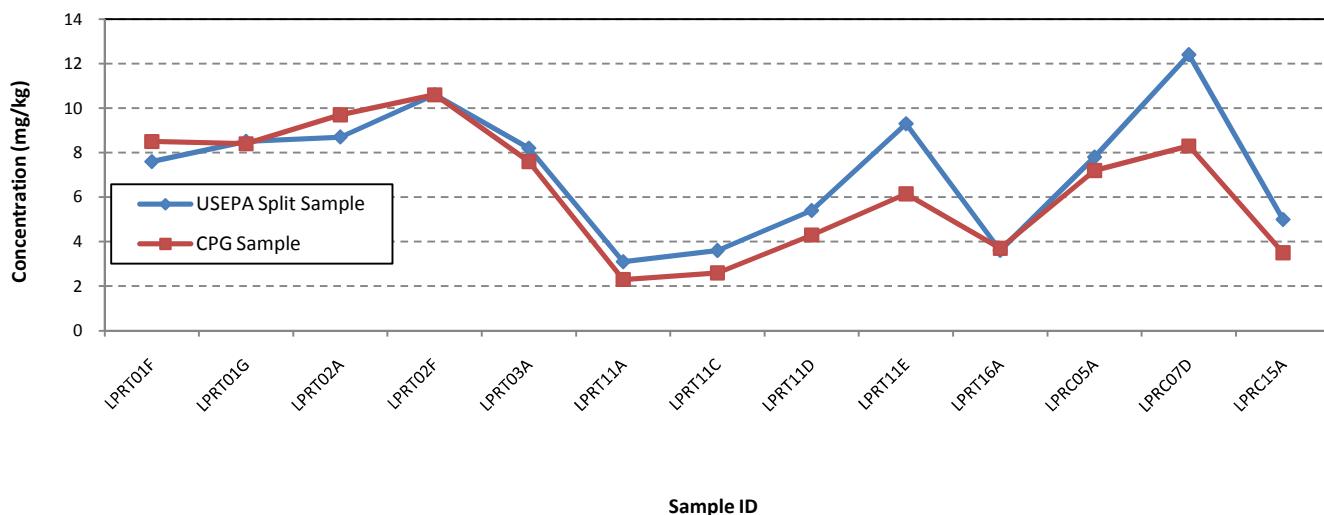


Figure 12b: Bivariate Plot of Cobalt Concentrations

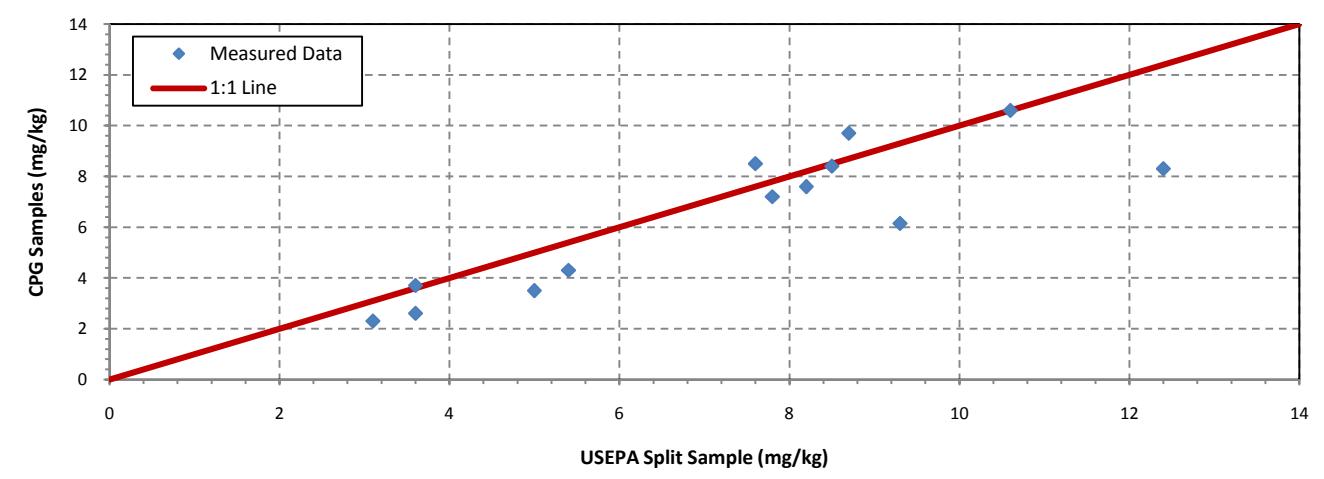


Figure 12c: Line Plot of Cobalt Percent Differences when USEPA and CPG both had Detected Concentrations

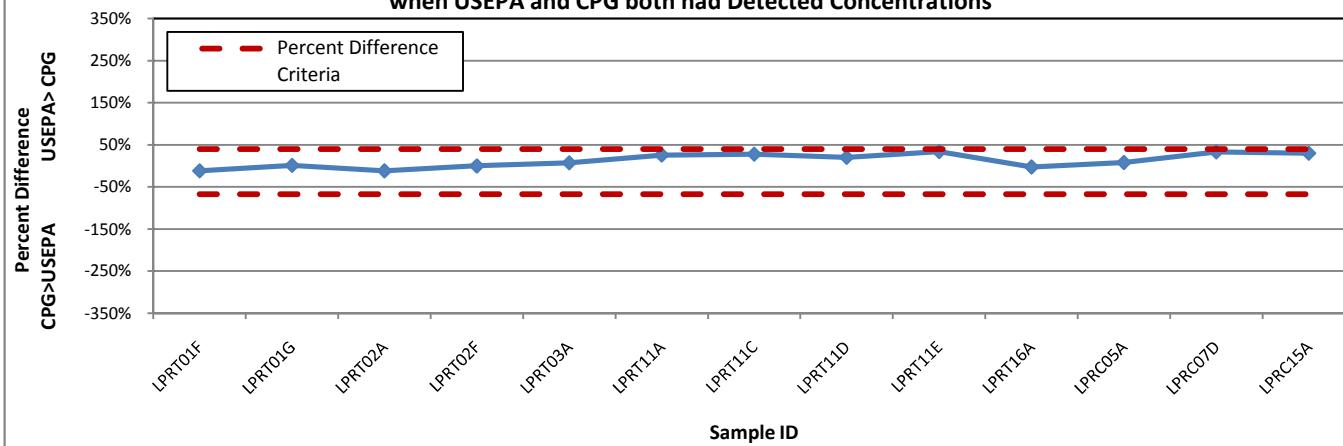


Figure 13a: Line Plot of Copper Concentrations



Figure 13b: Bivariate Plot of Copper Concentrations

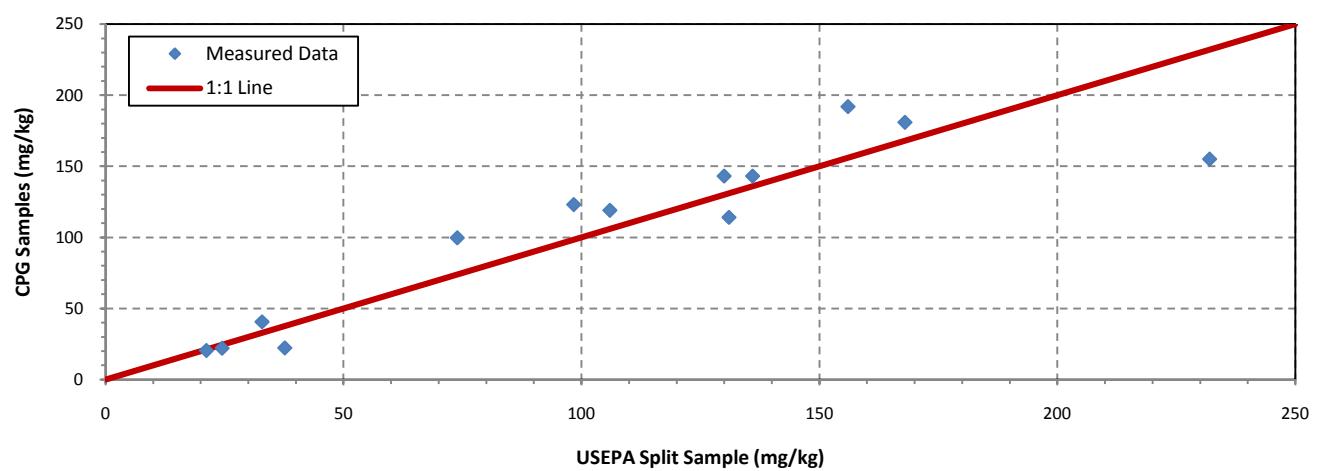


Figure 13c: Line Plot of Copper Percent Differences when USEPA and CPG both had Detected Concentrations

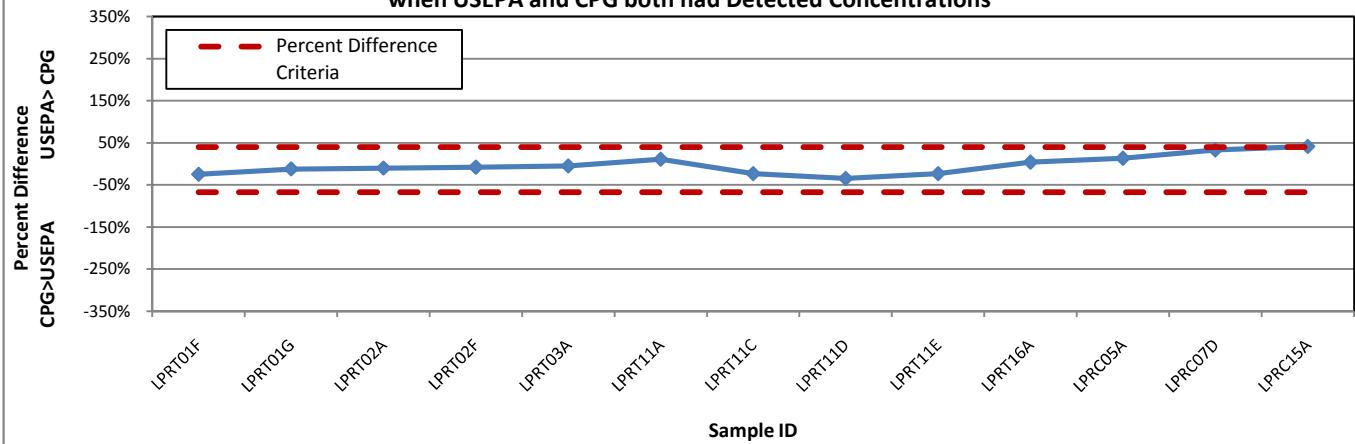


Figure 14a: Line Plot of Iron Concentrations

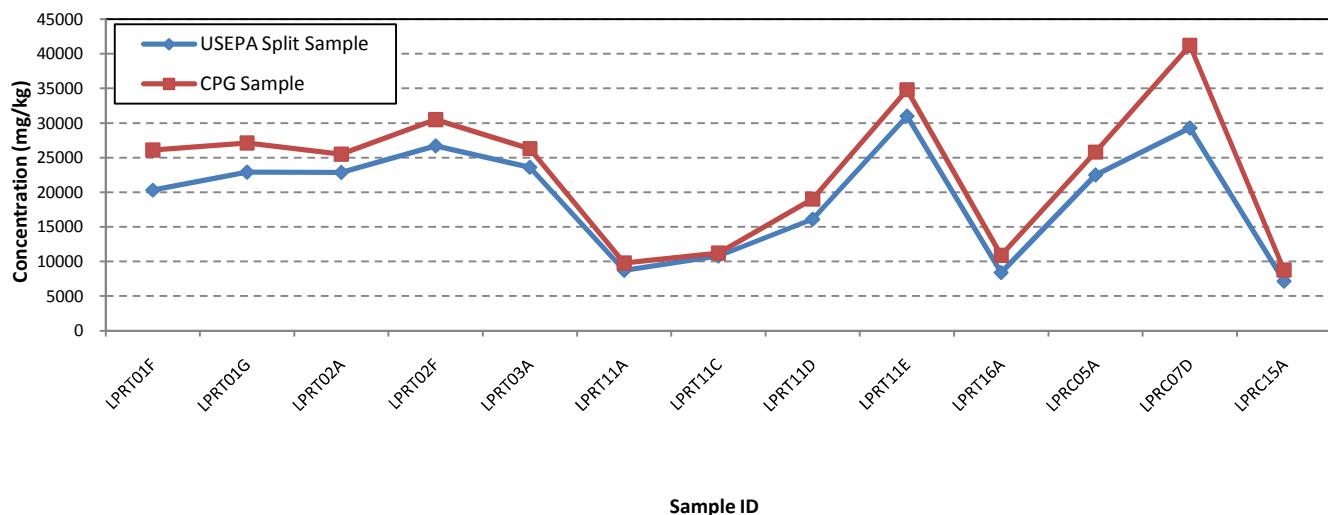


Figure 14b: Bivariate Plot of Iron Concentrations

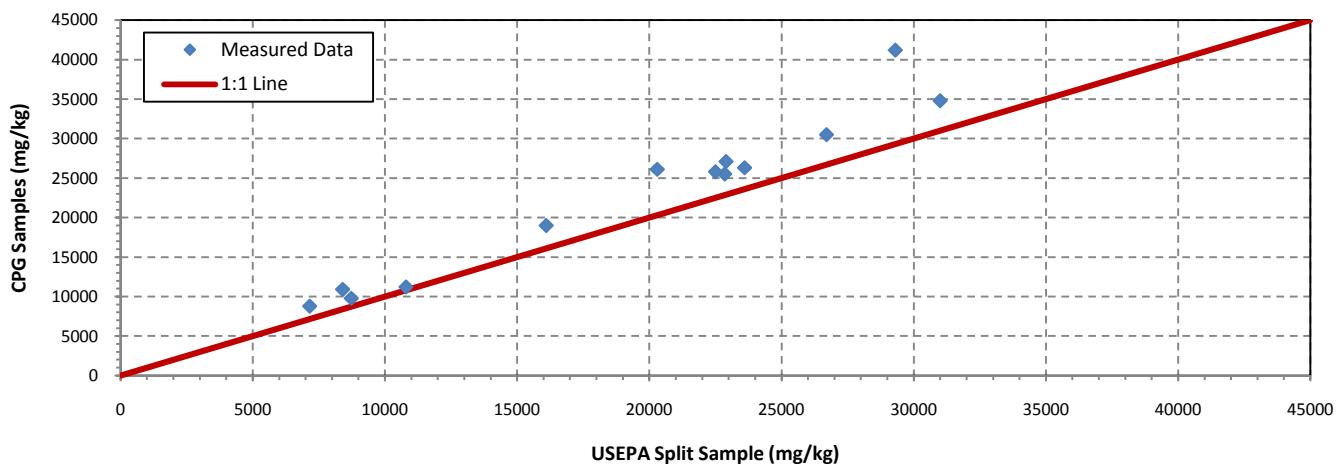


Figure 14c: Line Plot of Iron Percent Differences when USEPA and CPG both had Detected Concentrations

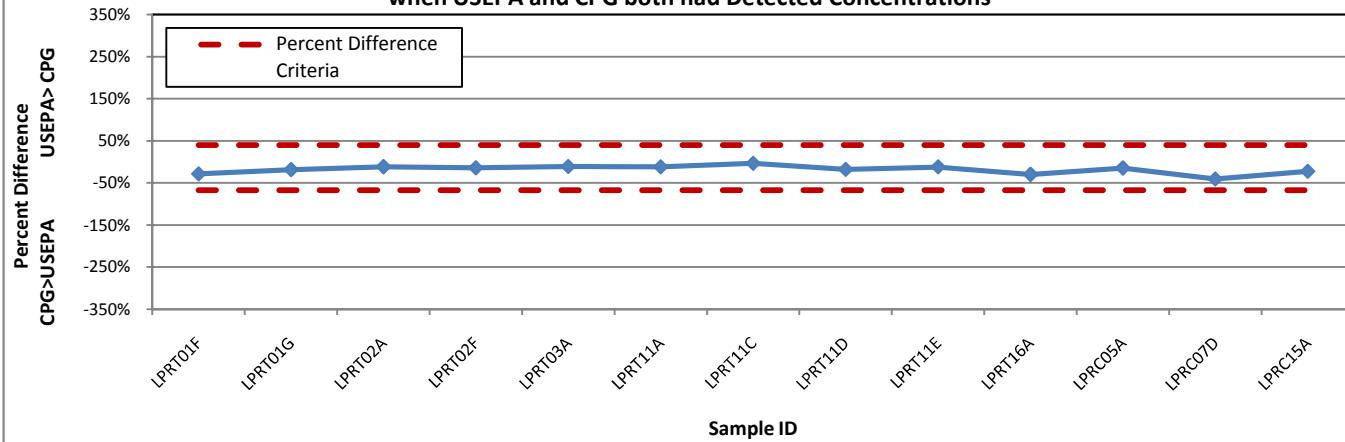


Figure 15a: Line Plot of Lead Concentrations

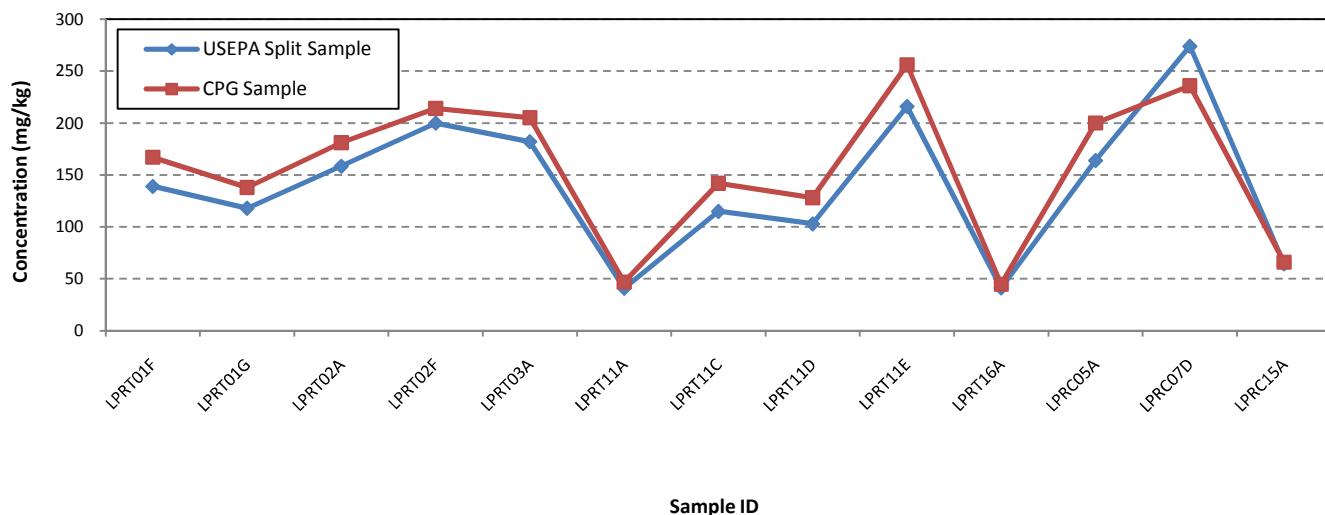


Figure 15b: Bivariate Plot of Lead Concentrations

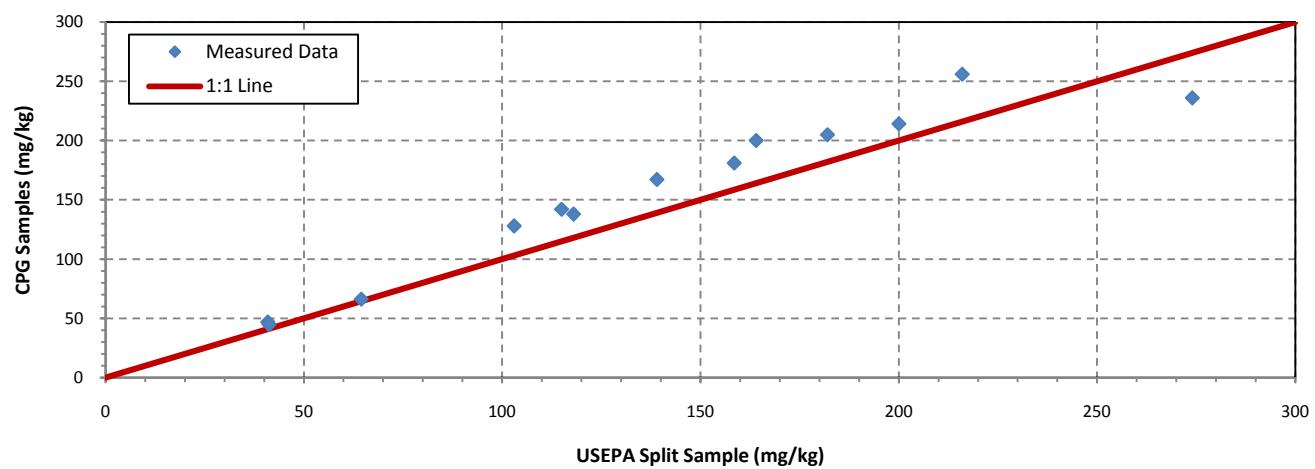


Figure 15c: Line Plot of Lead Percent Differences when USEPA and CPG both had Detected Concentrations

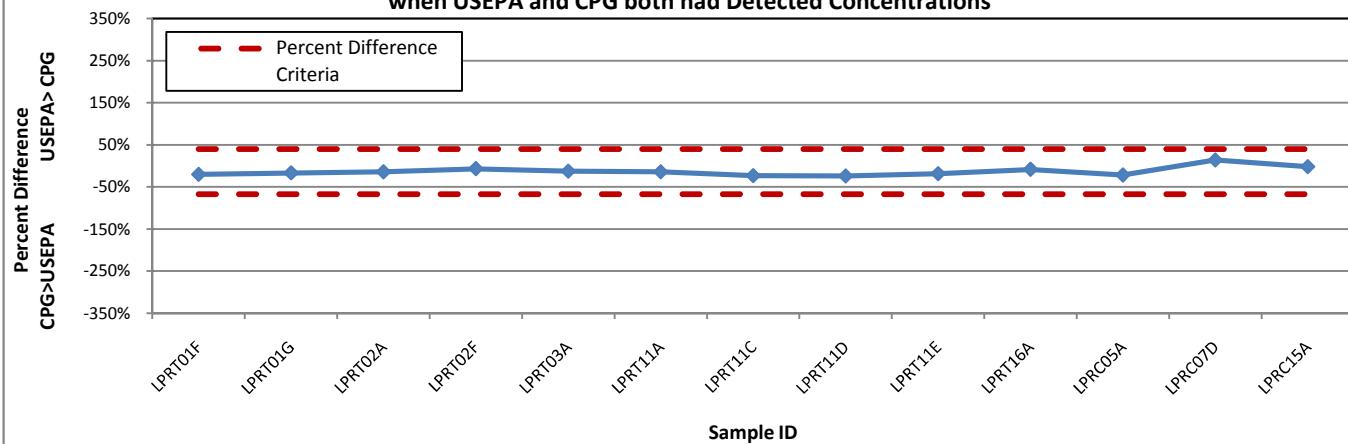


Figure 16a: Line Plot of Mercury Concentrations

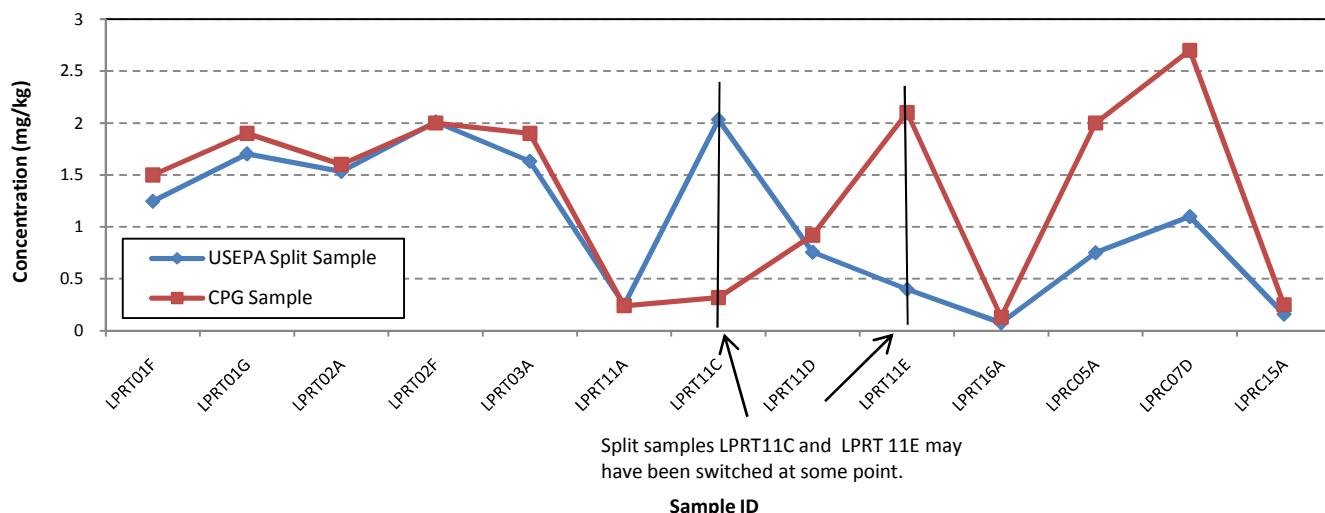


Figure 16b: Bivariate Plot of Mercury Concentrations

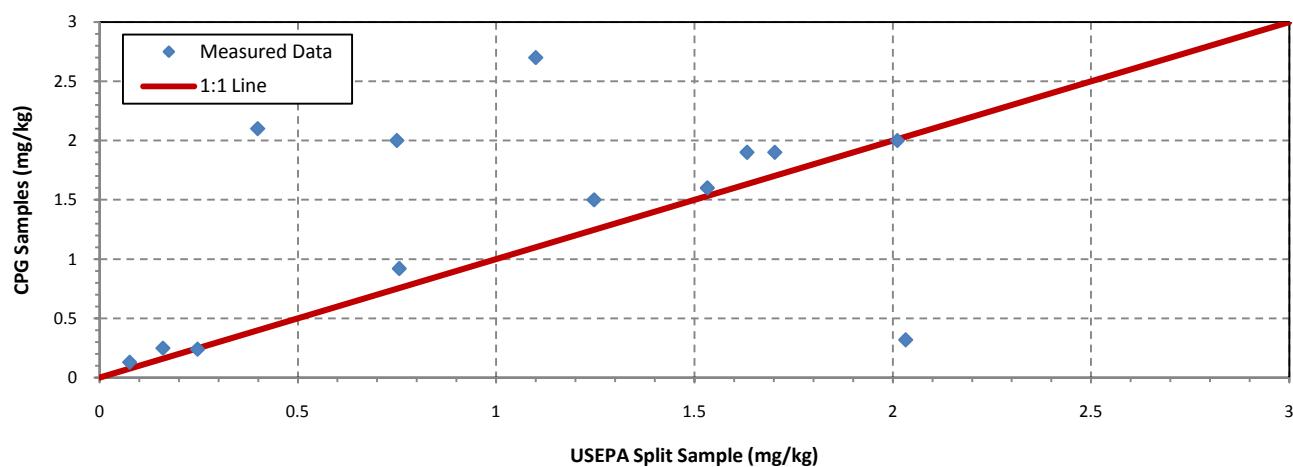


Figure 16c: Line Plot of Mercury Percent Differences when USEPA and CPG both had Detected Concentrations

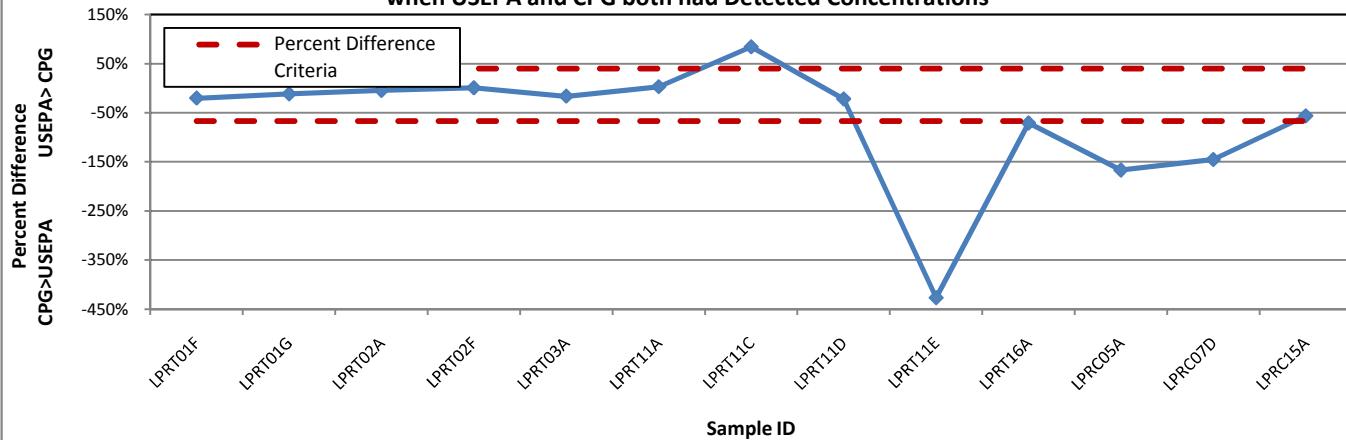


Figure 17a: Line Plot of Nickel Concentrations

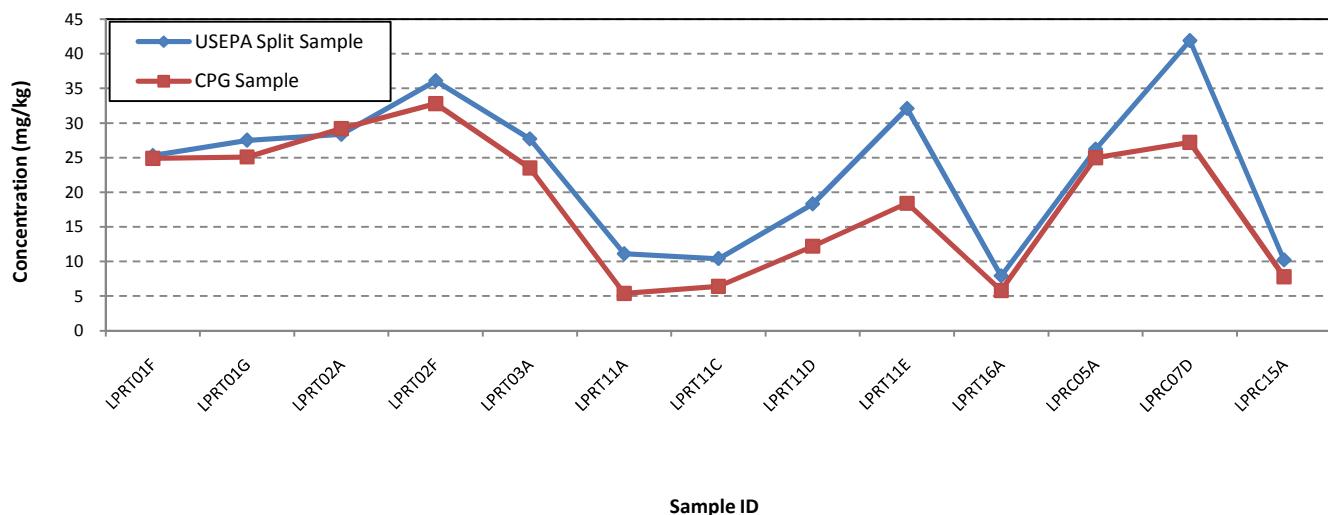


Figure 17b: Bivariate Plot of Nickel Concentrations

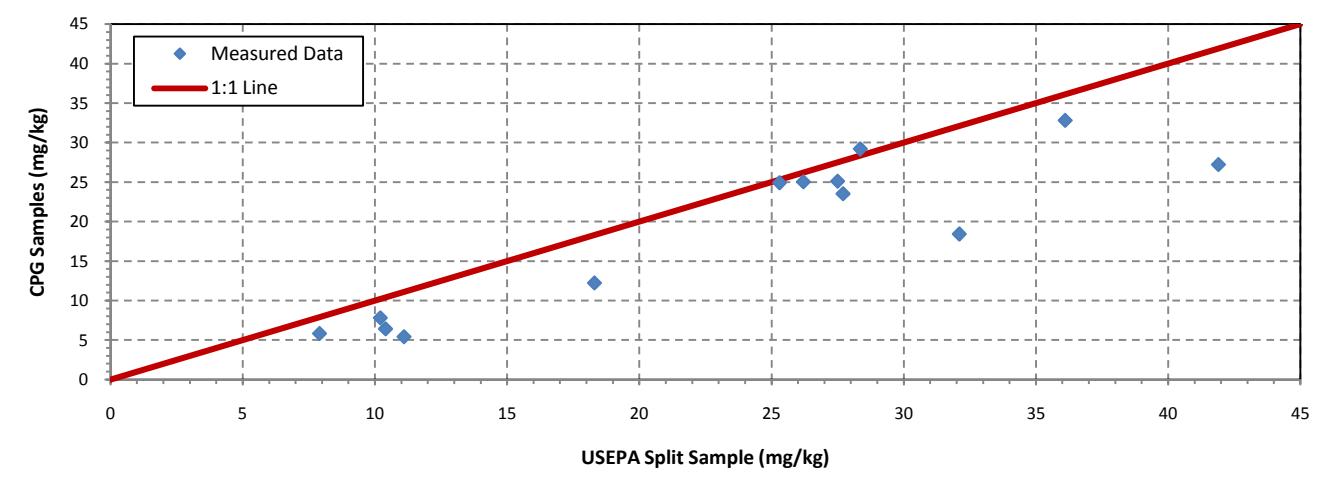


Figure 17c: Line Plot of Nickel Percent Differences when USEPA and CPG both had Detected Concentrations

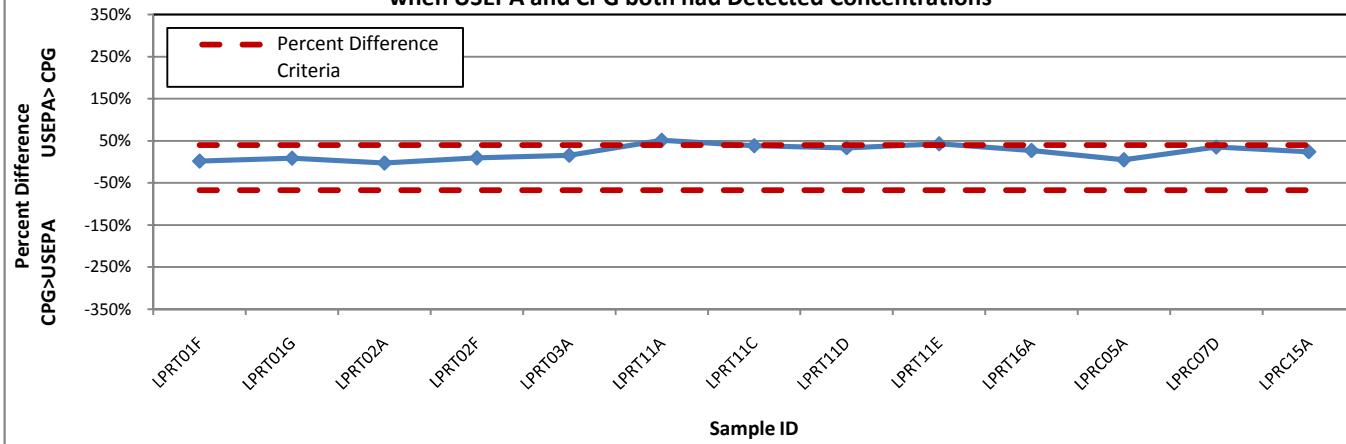


Figure 18a: Line Plot of Zinc Concentrations

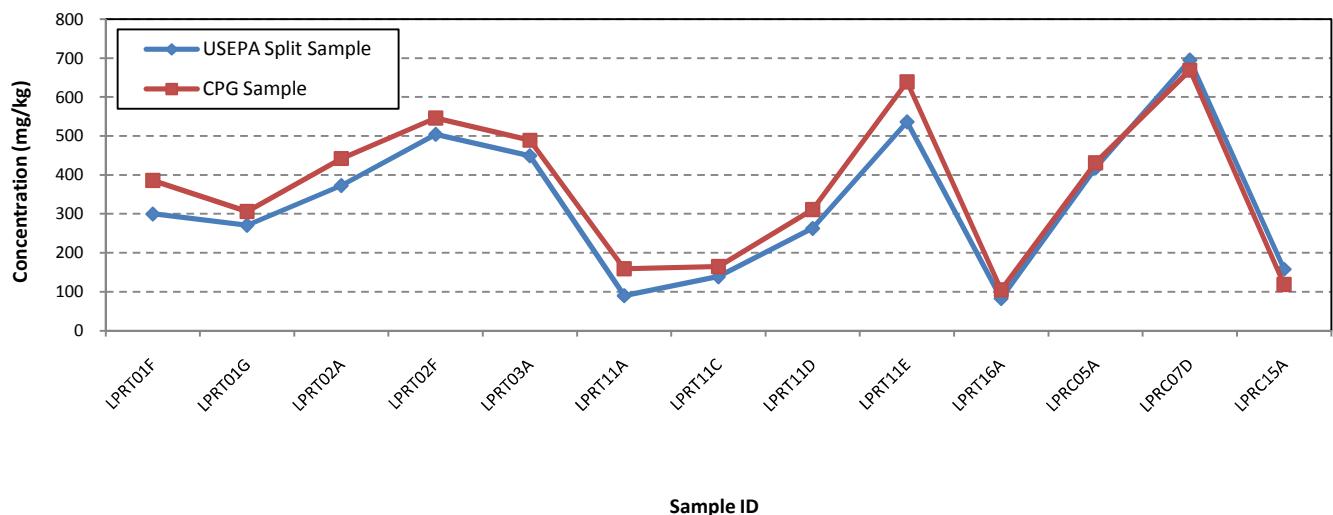


Figure 18b: Bivariate Plot of Zinc Concentrations

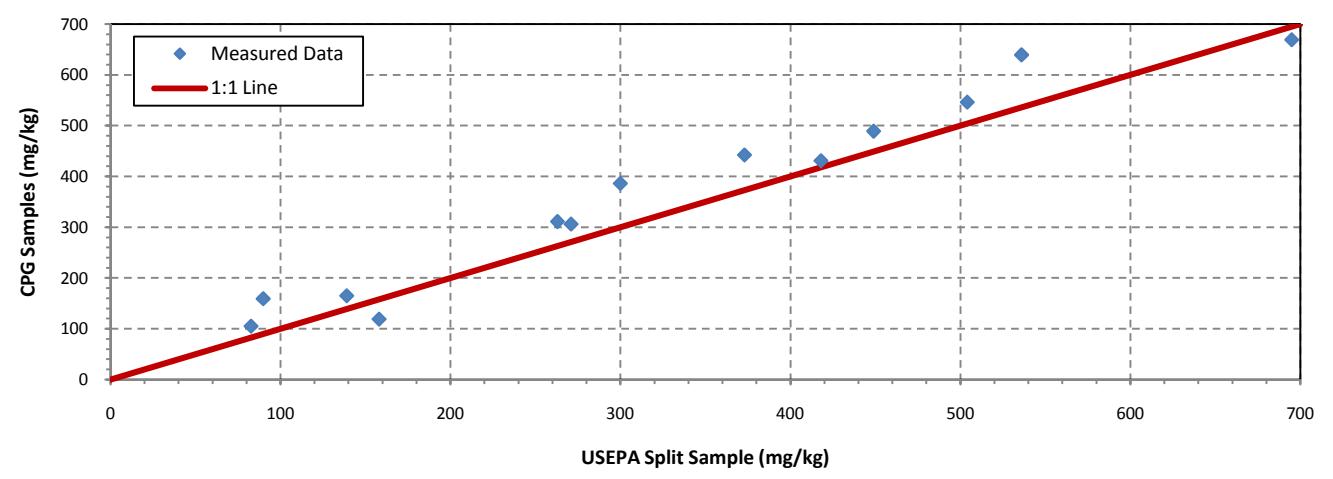


Figure 18c: Line Plot of Zinc Percent Differences when USEPA and CPG both had Detected Concentrations

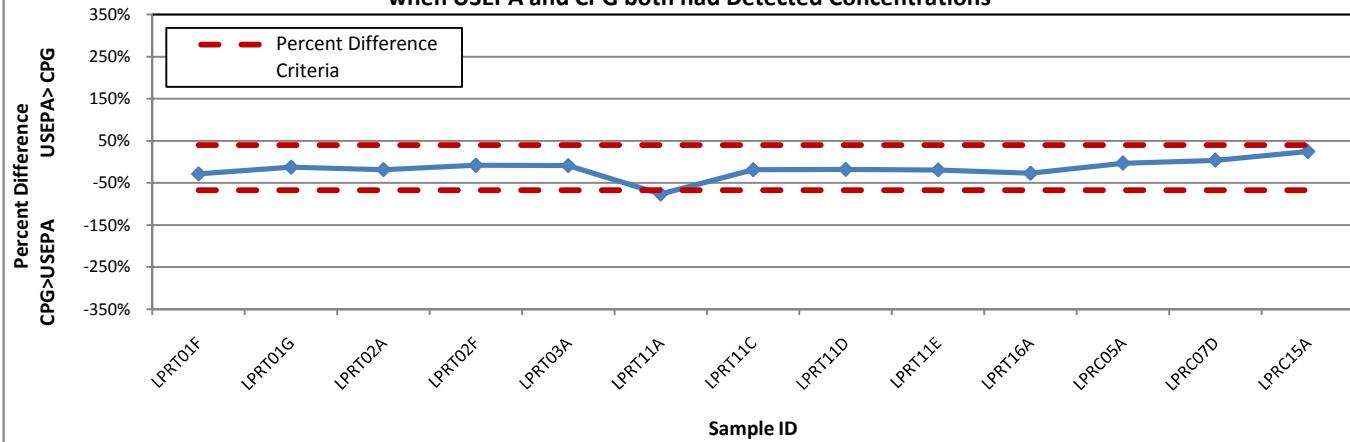


Figure 19a: Line Plot of Methyl Mercury Concentrations

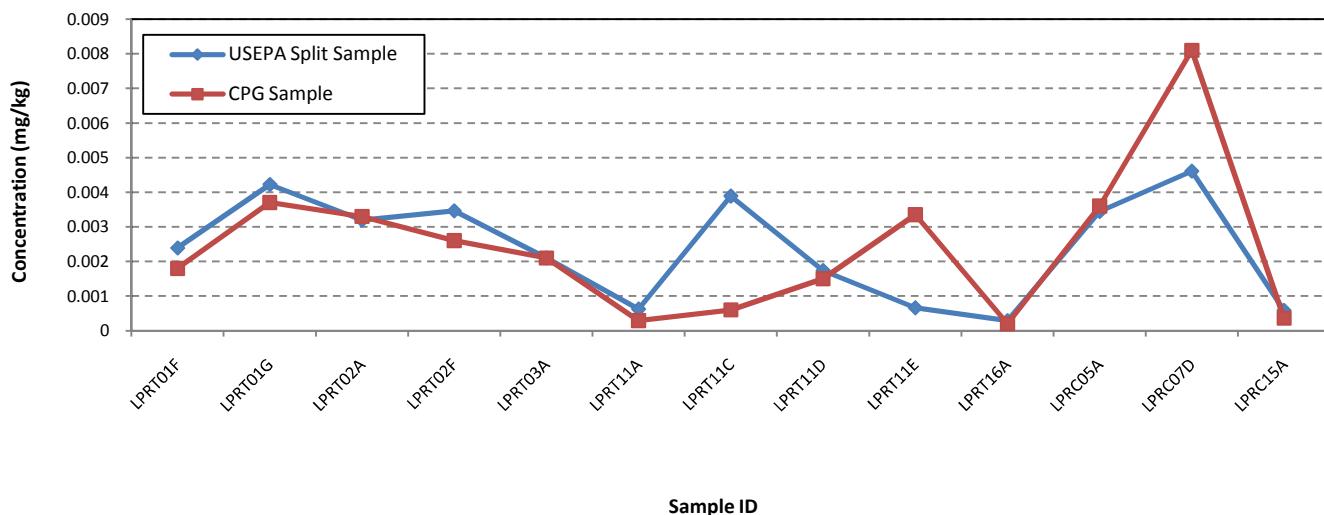


Figure 19b: Bivariate Plot of Methyl Mercury Concentrations

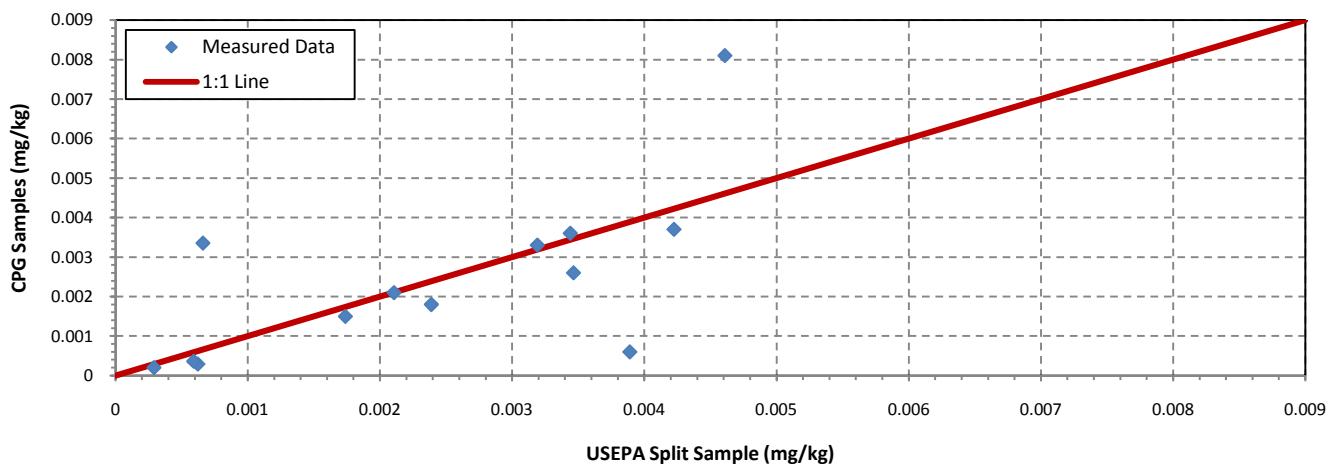


Figure 19c: Line Plot of Methyl Mercury Percent Differences when USEPA and CPG both had Detected Concentrations

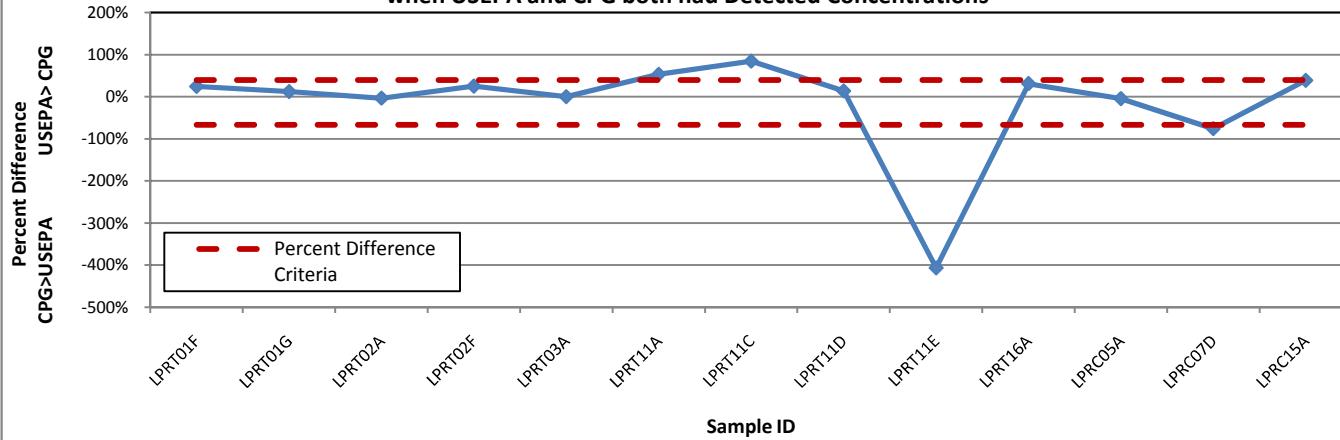


Figure 20a: Line Plot of Anthracene Concentrations

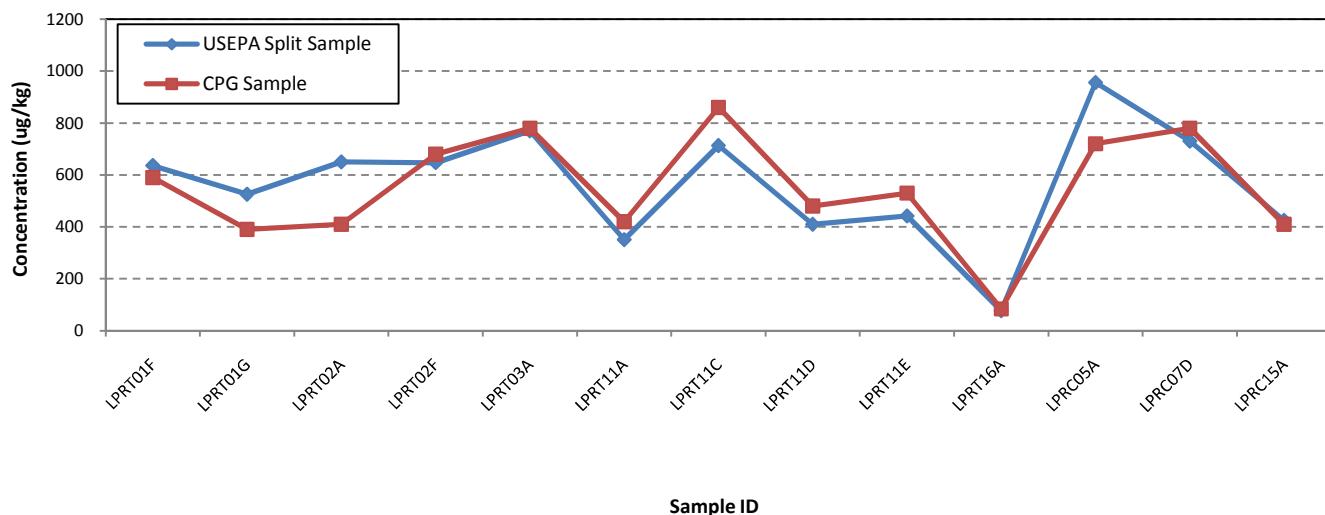


Figure 20b: Bivariate Plot of Anthracene Concentrations

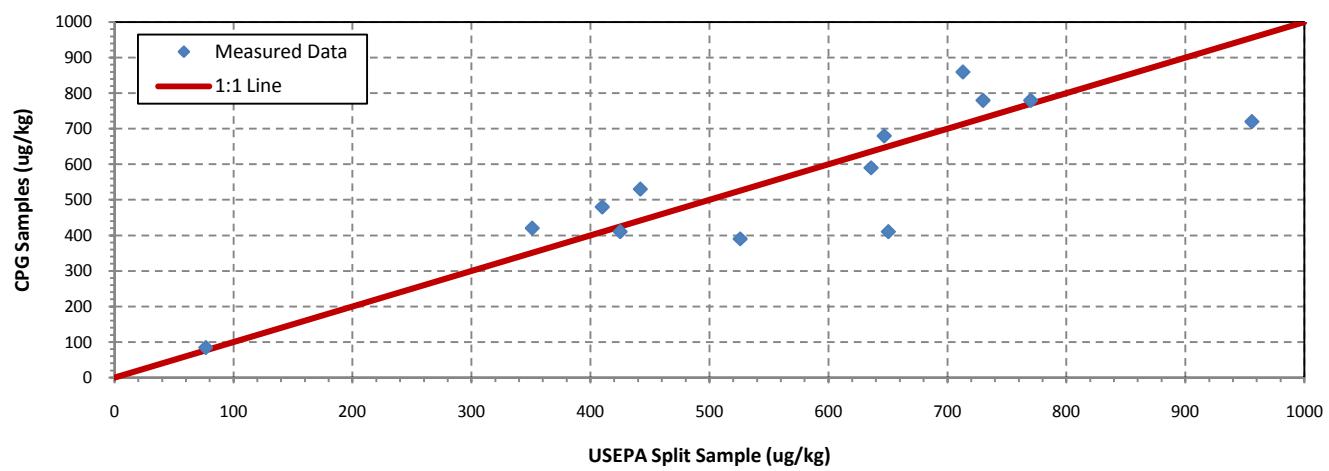


Figure 20c: Line Plot of Anthracene Percent Differences when USEPA and CPG both had Detected Concentrations

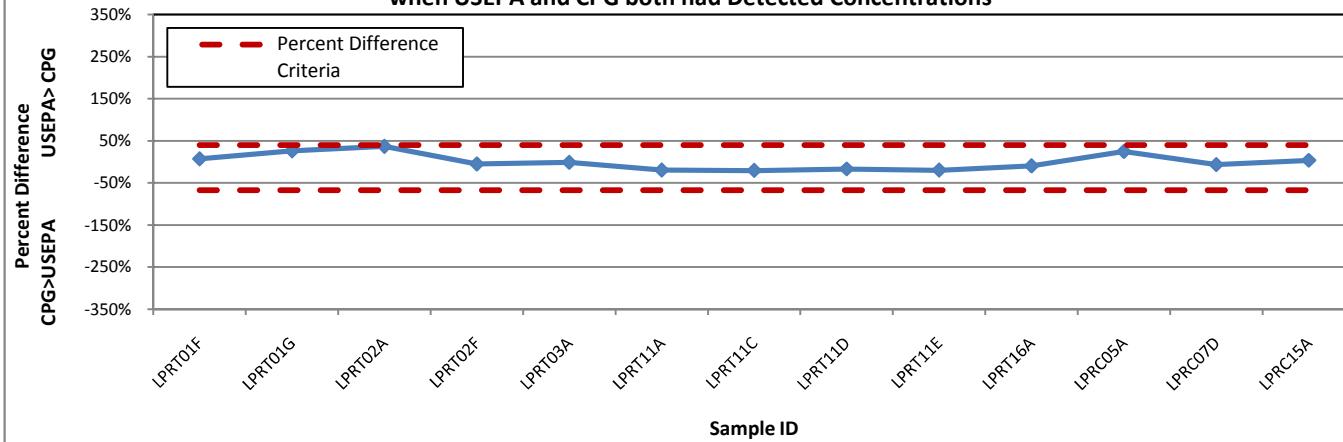


Figure 21a: Line Plot of Benzo(a)anthracene Concentrations

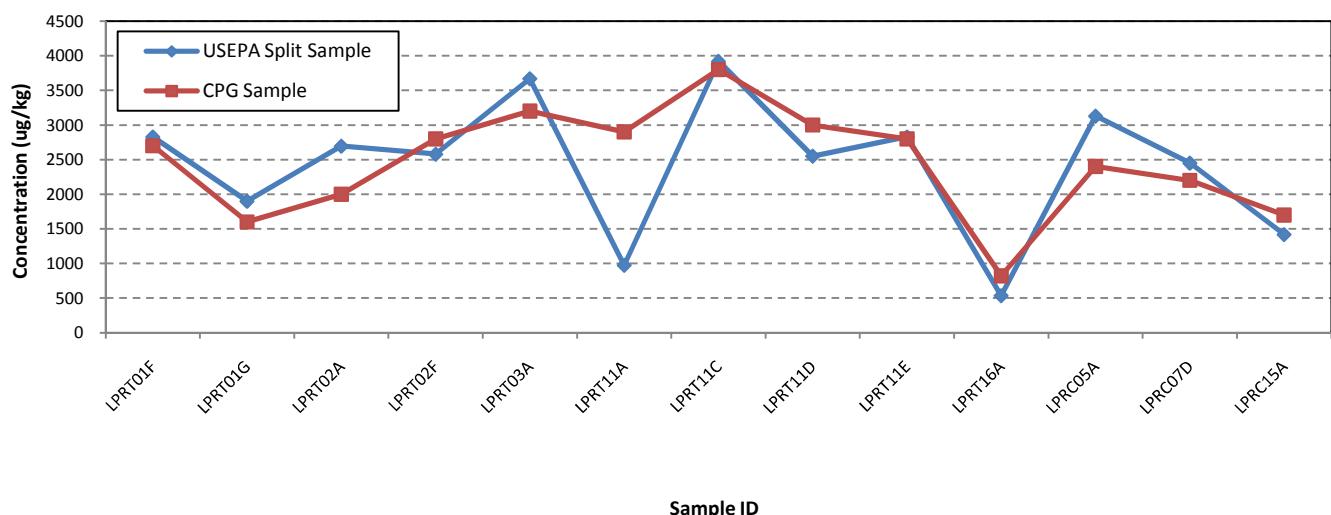


Figure 21b: Bivariate Plot of Benzo(a)anthracene Concentrations

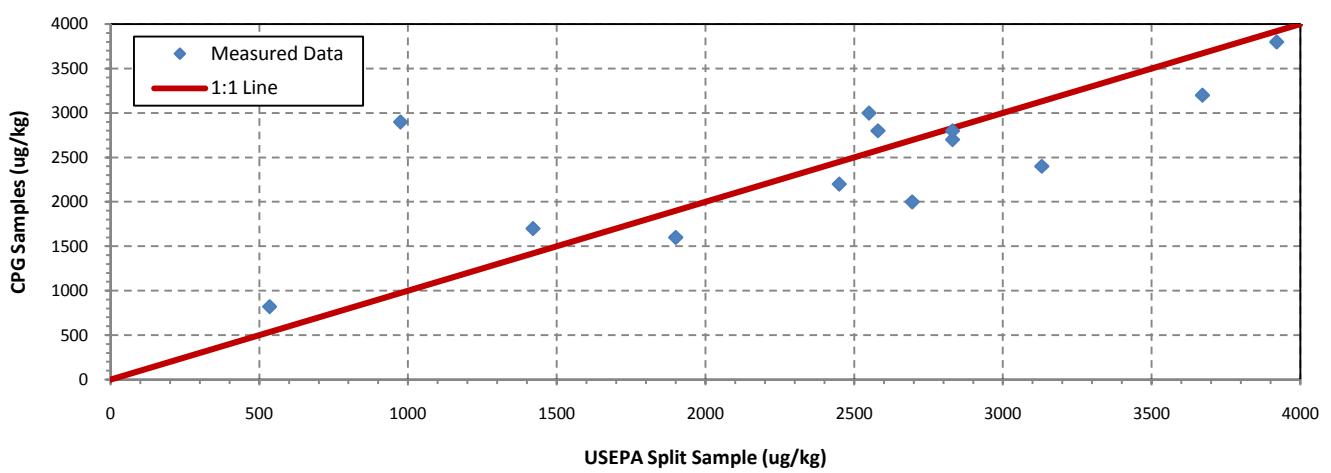


Figure 21c: Line Plot of Benzo(a)anthracene Percent Differences when USEPA and CPG both had Detected Concentrations

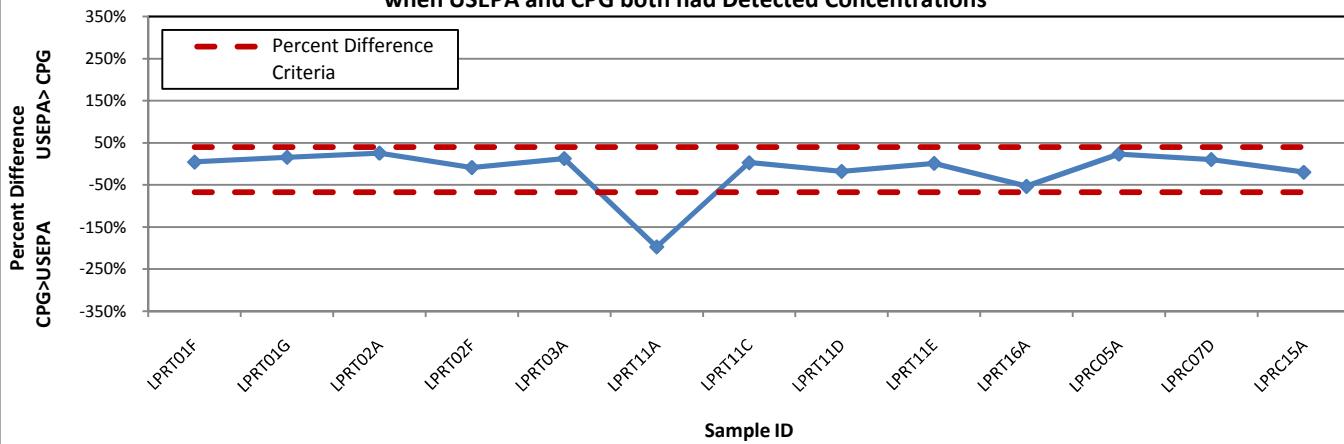


Figure 22a: Line Plot of Benzo(a)pyrene Concentrations

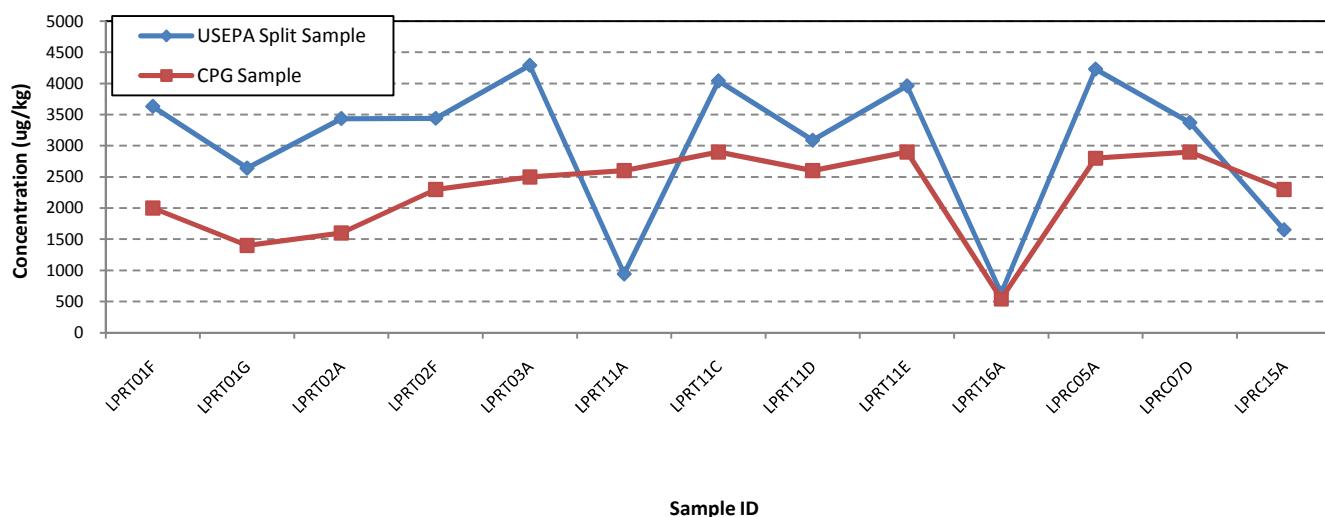


Figure 22b: Bivariate Plot of Benzo(a)pyrene Concentrations

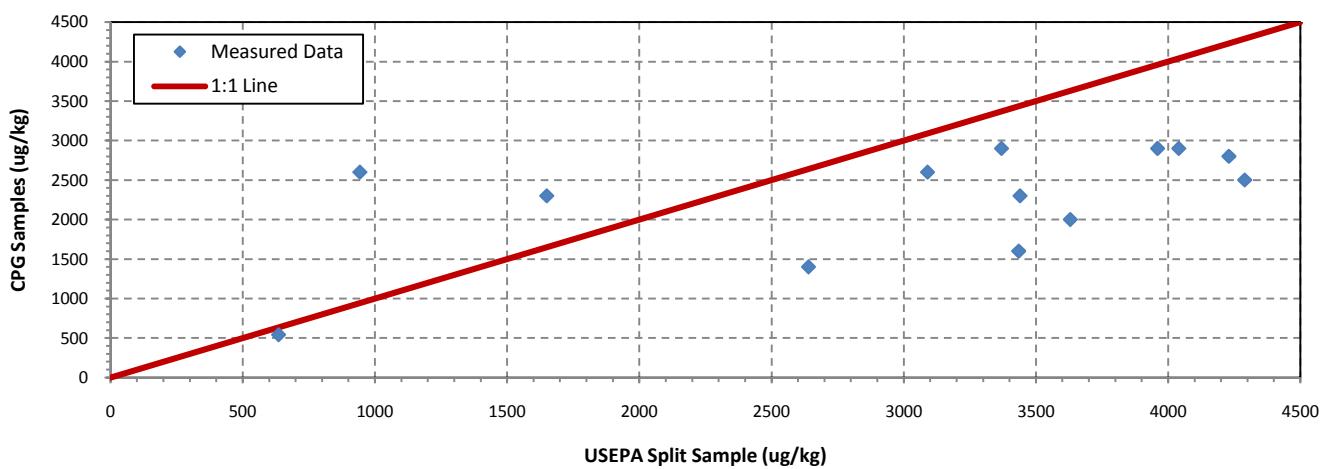


Figure 22c: Line Plot of Benzo(a)pyrene Percent Differences when USEPA and CPG both had Detected Concentrations

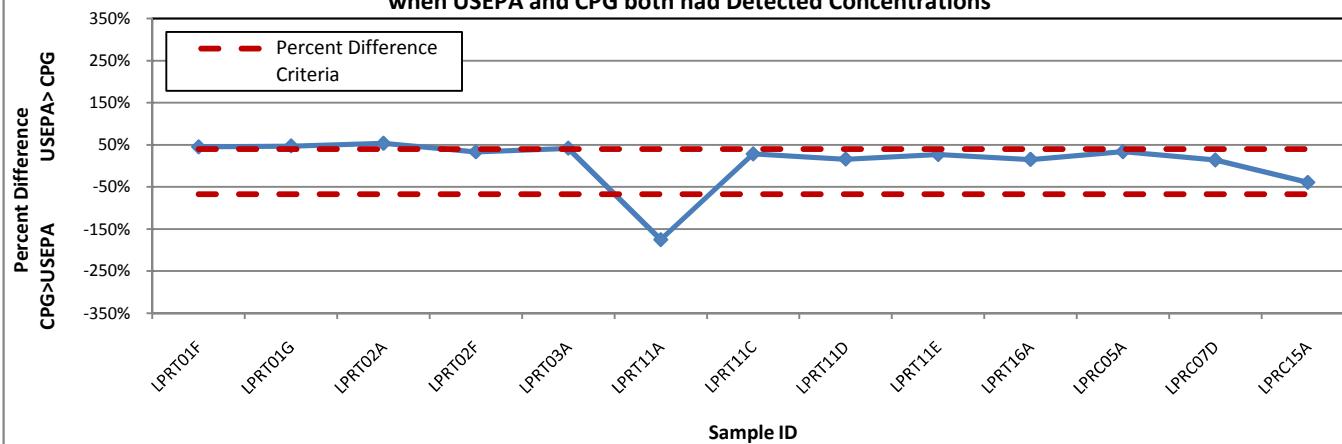


Figure 23a: Line Plot of Chrysene Concentrations

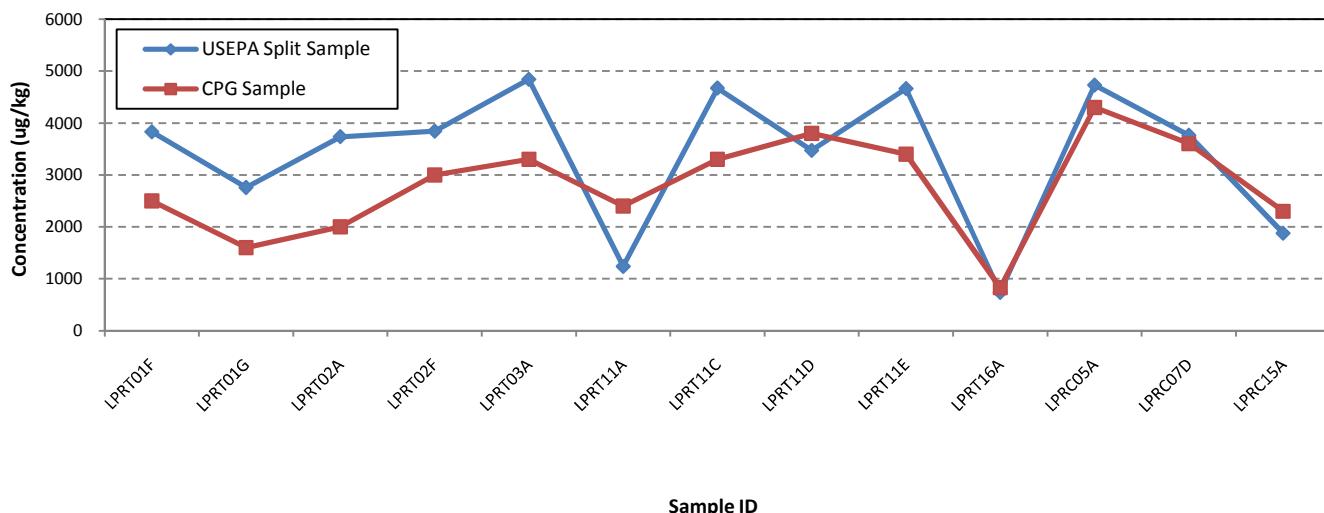


Figure 23b: Bivariate Plot of Chrysene Concentrations

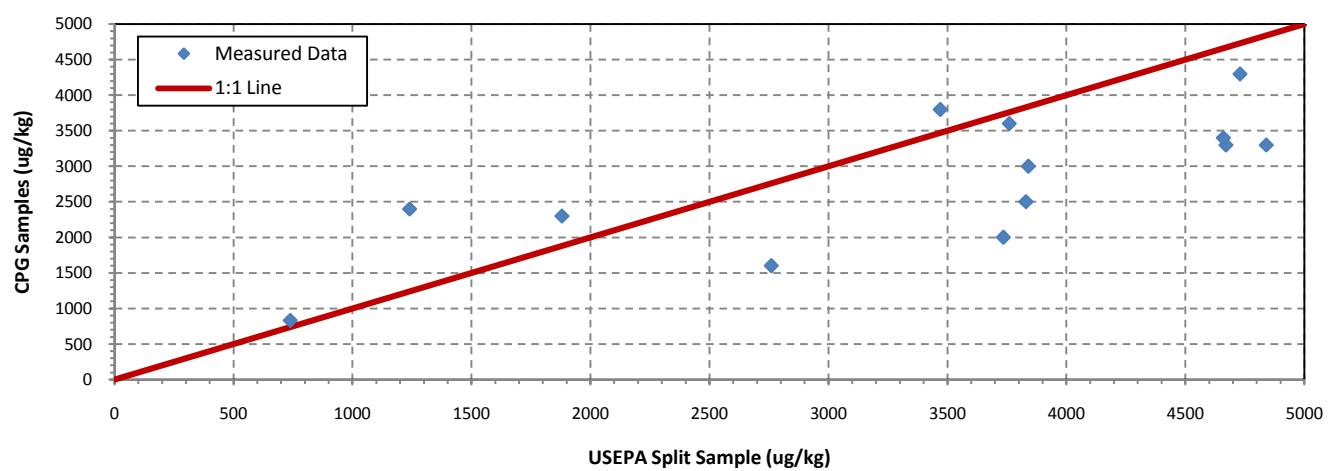


Figure 23c: Line Plot of Chrysene Percent Differences when USEPA and CPG both had Detected Concentrations

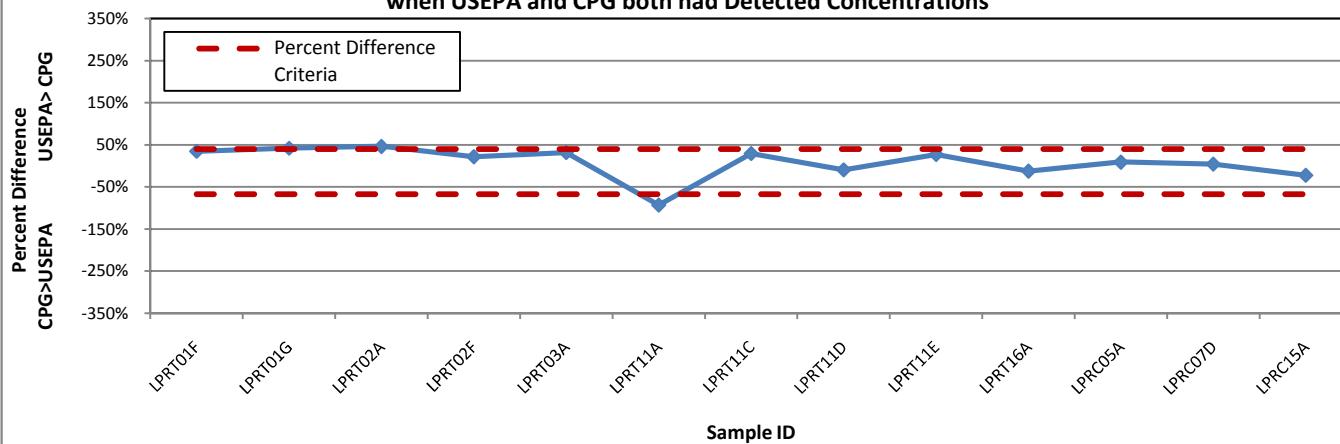


Figure 24a: Line Plot of Fluoranthene Concentrations

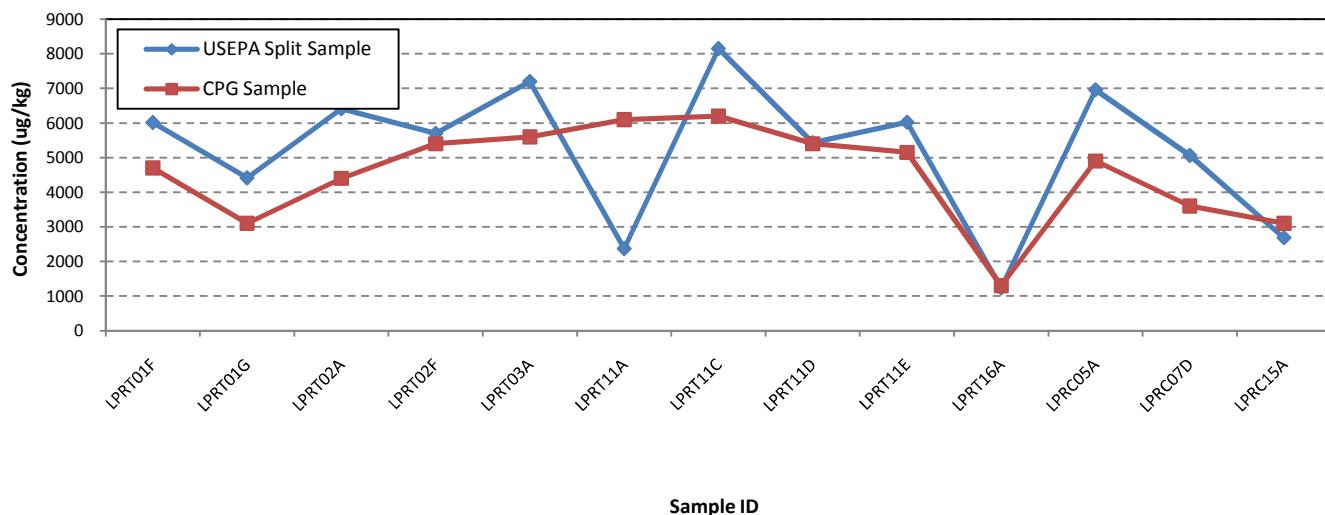


Figure 24b: Bivariate Plot of Fluoranthene Concentrations

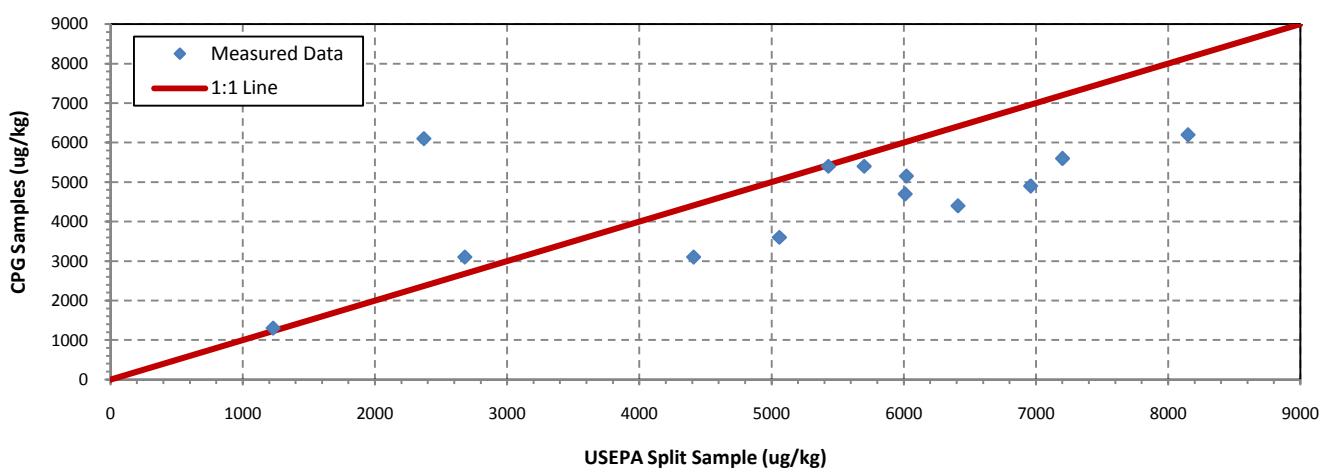


Figure 24c: Line Plot of Fluoranthene Percent Differences when USEPA and CPG both had Detected Concentrations

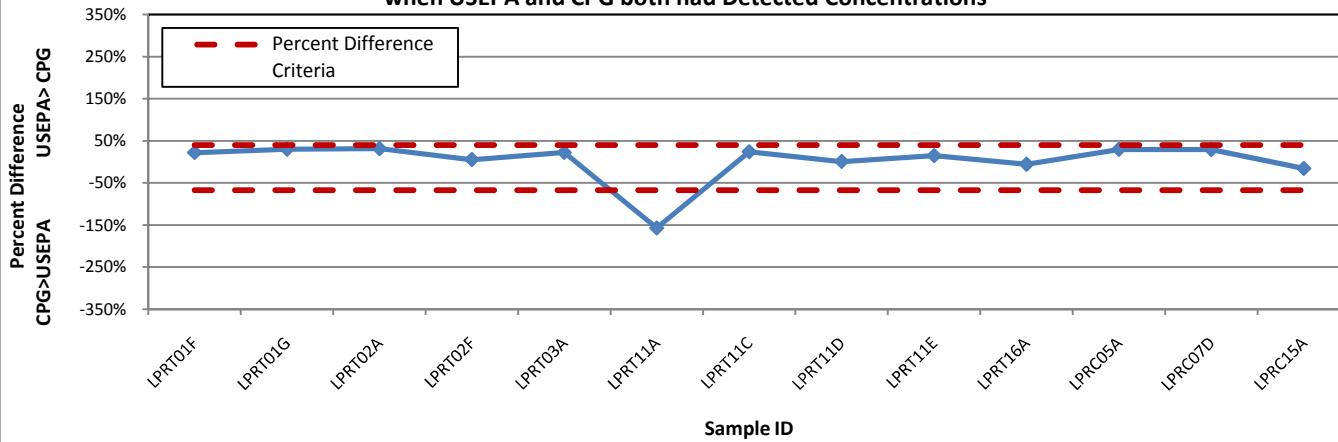


Figure 25a: Line Plot of Indeno[1,2,3-cd]pyrene Concentrations

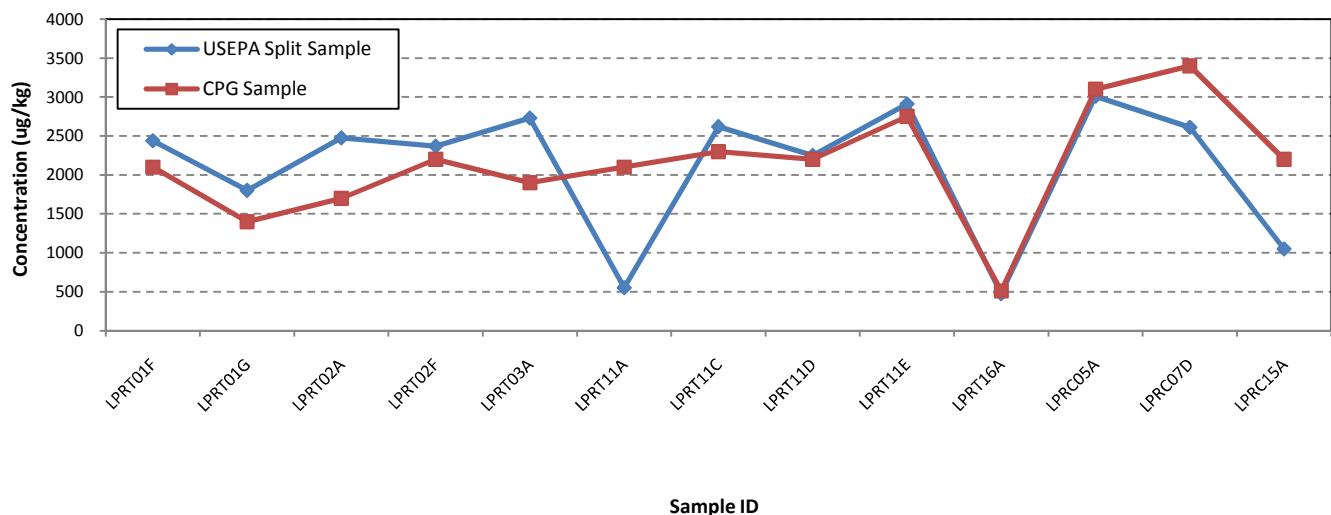


Figure 25b: Bivariate Plot of Indeno[1,2,3-cd]pyrene Concentrations

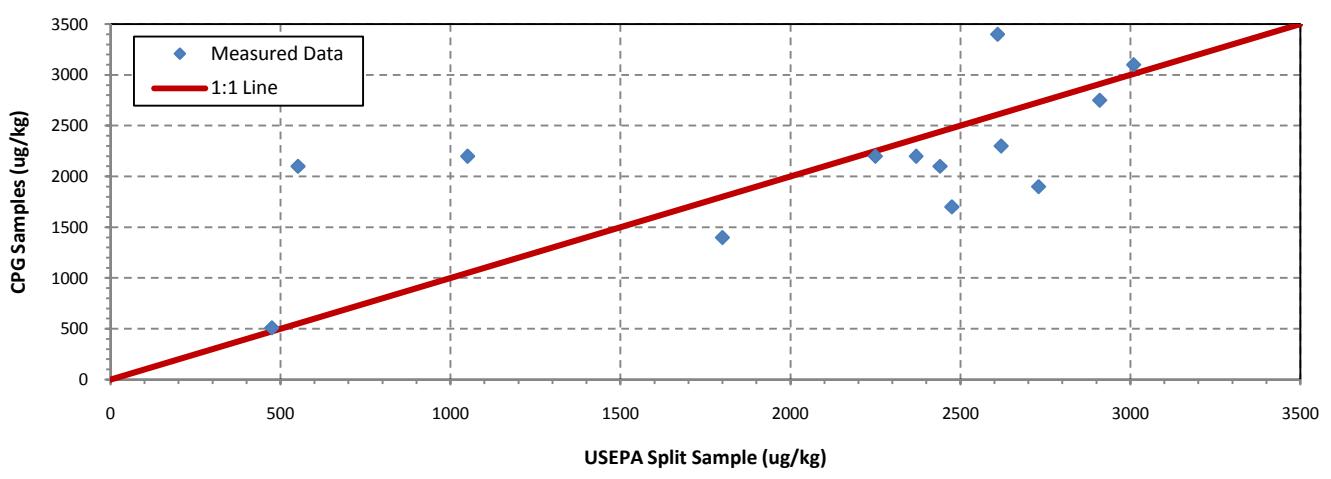


Figure 25c: Line Plot of Indeno[1,2,3-cd]pyrene Percent Differences when USEPA and CPG both had Detected Concentrations

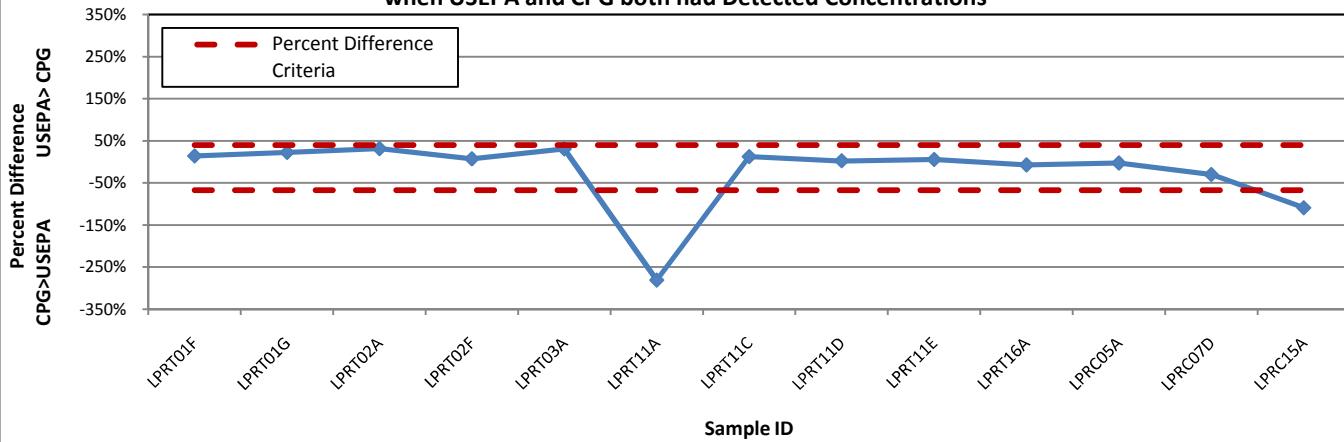
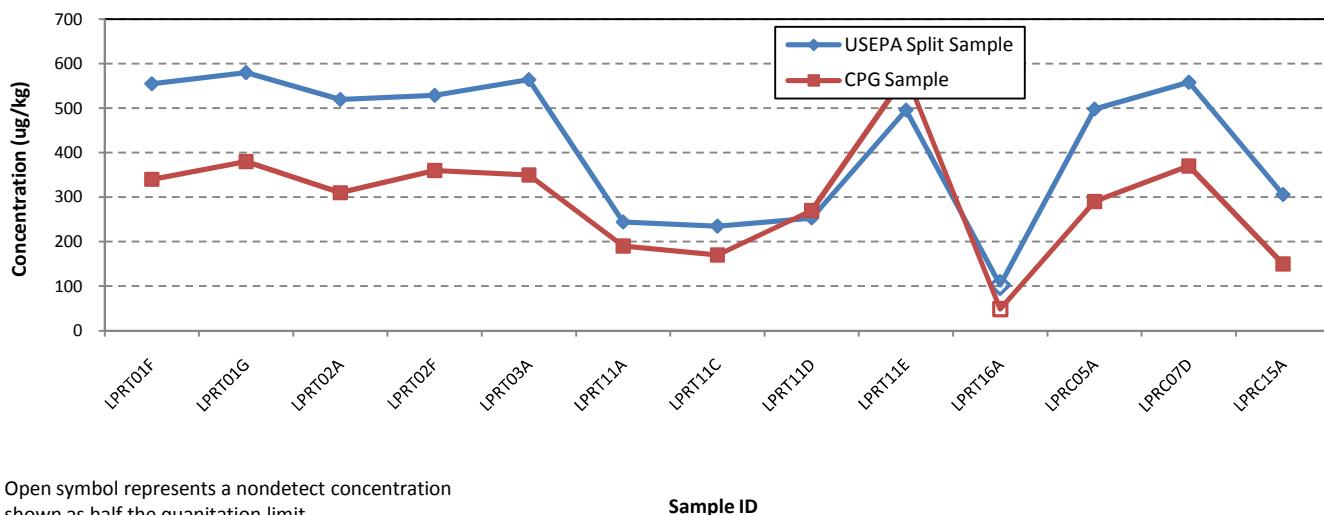


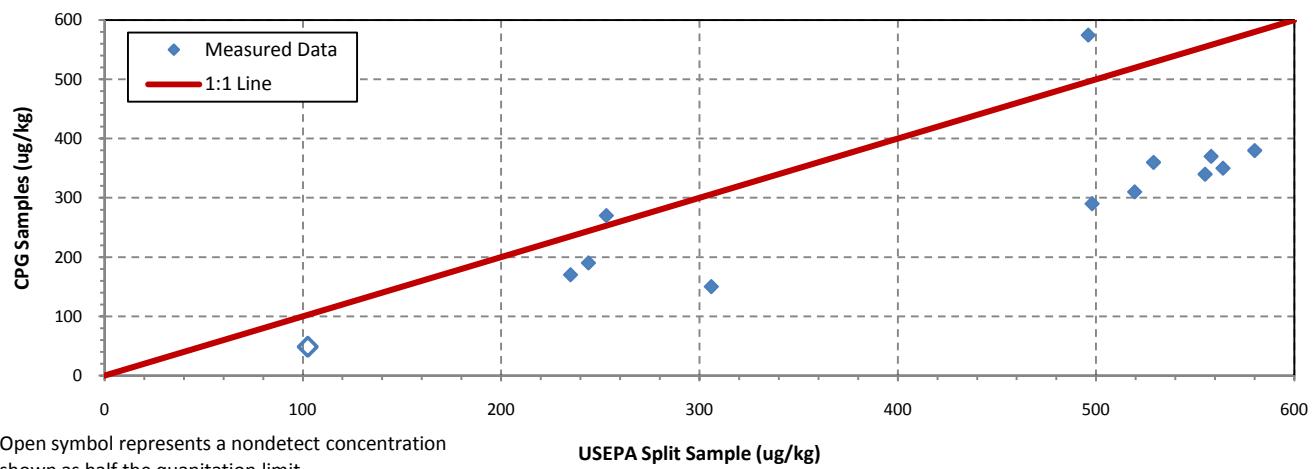
Figure 26a: Line Plot of Naphthalene Concentrations



Open symbol represents a nondetect concentration shown as half the quantitation limit.

Sample ID

Figure 2b: Bivariate Plot of Naphthalene Concentrations



Open symbol represents a nondetect concentration shown as half the quantitation limit.

Sample ID

Figure 2c: Line Plot of Naphthalene Percent Differences when USEPA and CPG both had Detected Concentrations

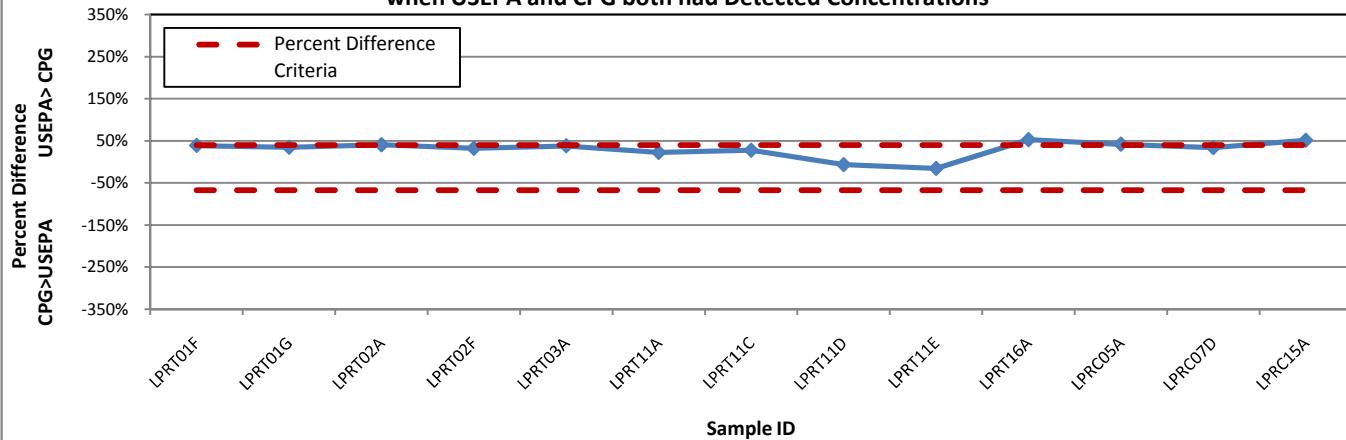


Figure 27a: Line Plot of Phenanthrene Concentrations

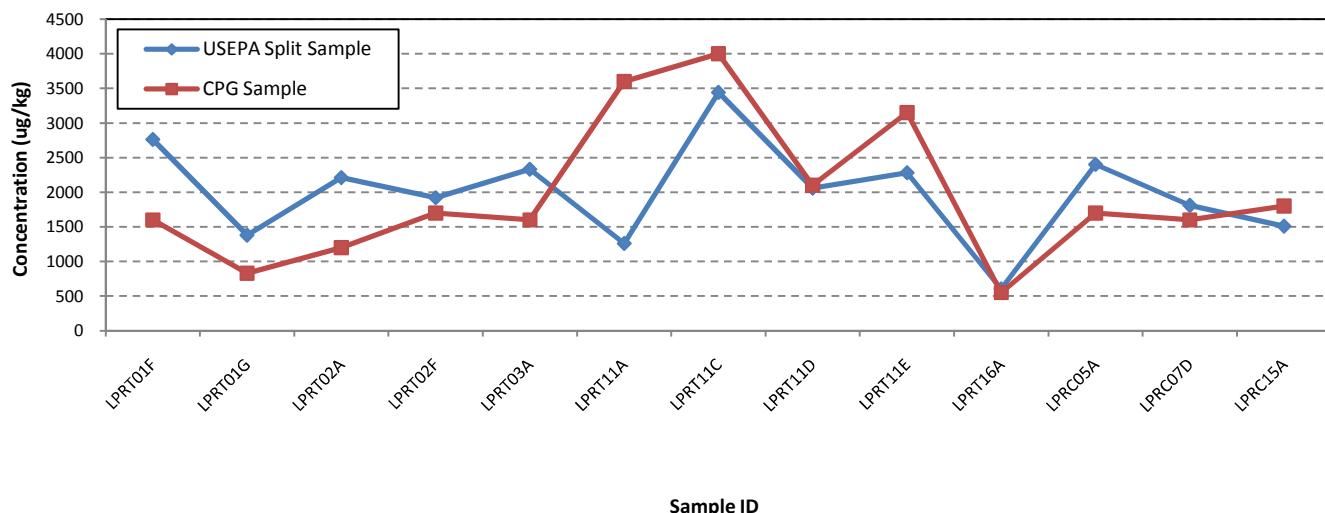


Figure 27b: Bivariate Plot of Phenanthrene Concentrations

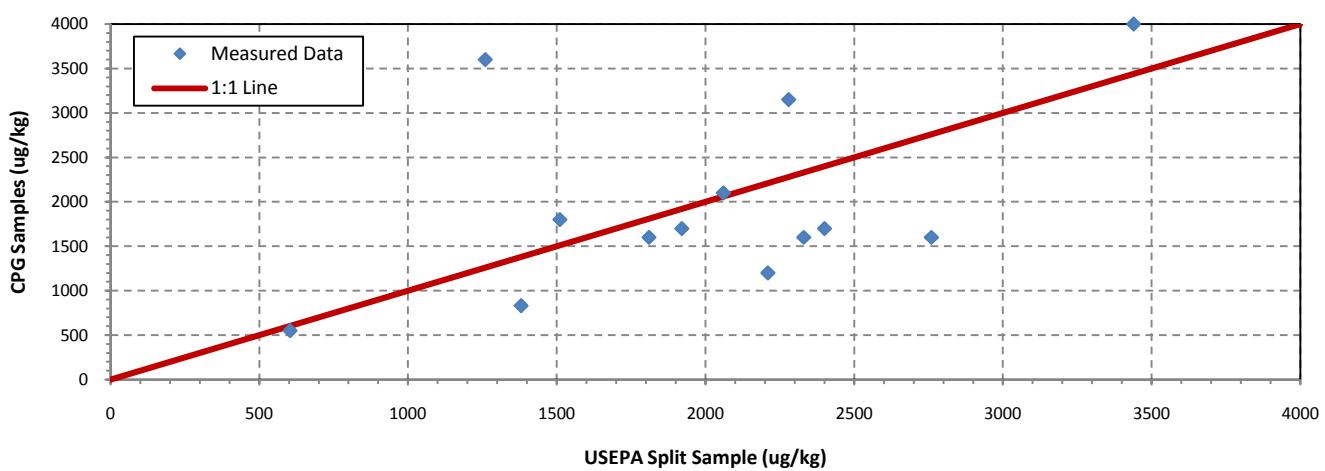


Figure 27c: Line Plot of Phenanthrene Percent Differences when USEPA and CPG both had Detected Concentrations

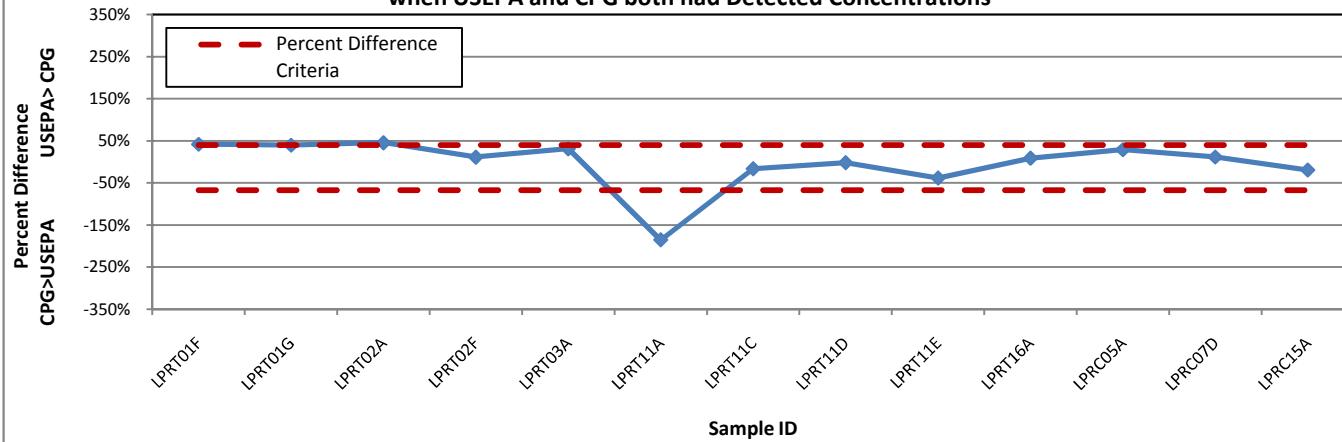


Figure 28a: Line Plot of Pyrene Concentrations

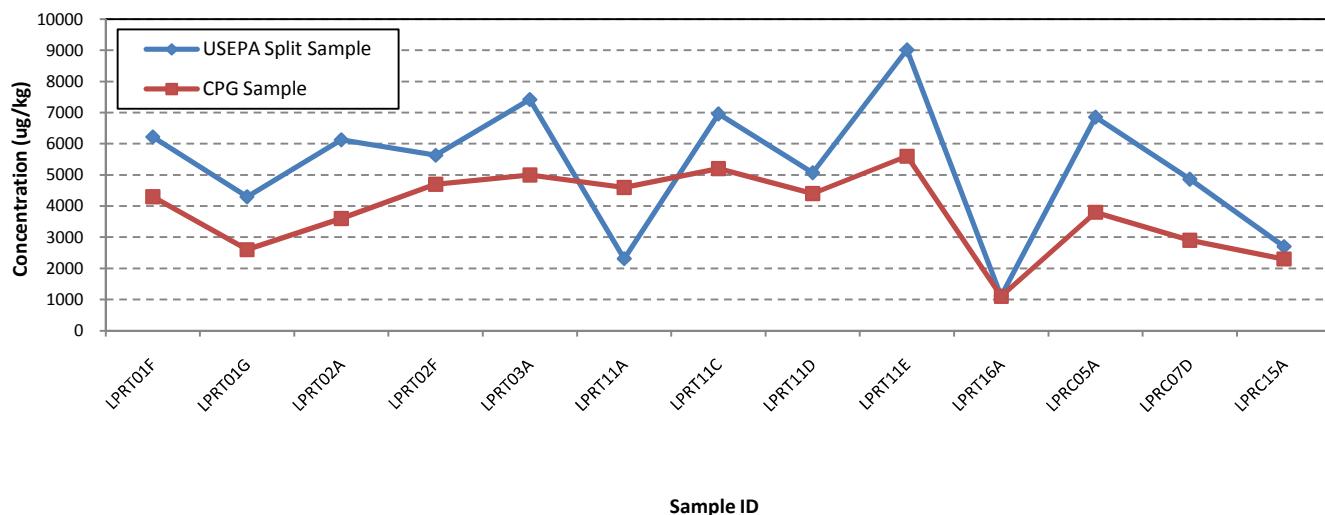


Figure 28b: Bivariate Plot of Pyrene Concentrations

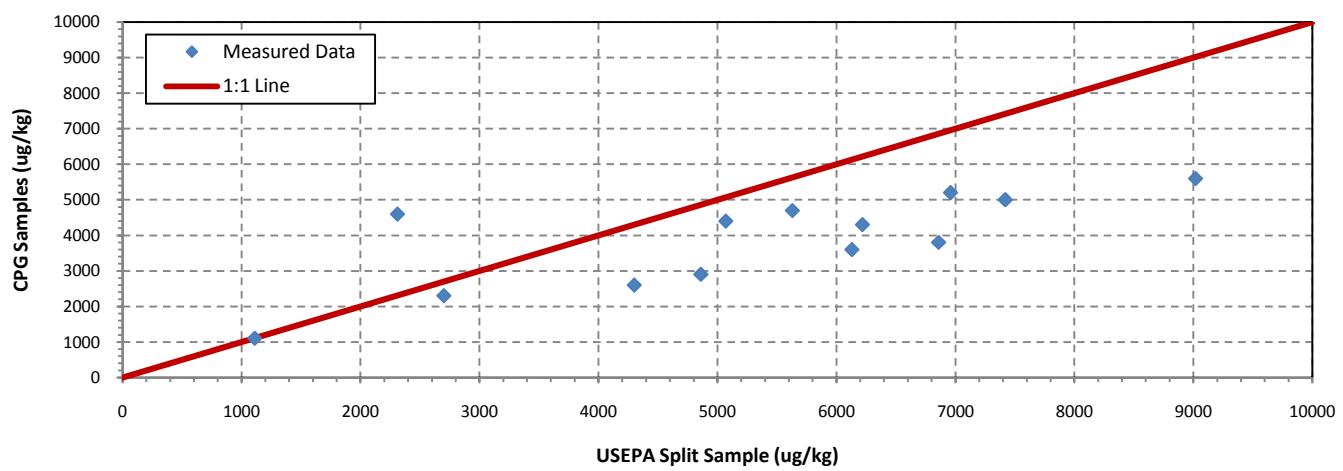


Figure 28c: Line Plot of Pyrene Percent Differences when USEPA and CPG both had Detected Concentrations

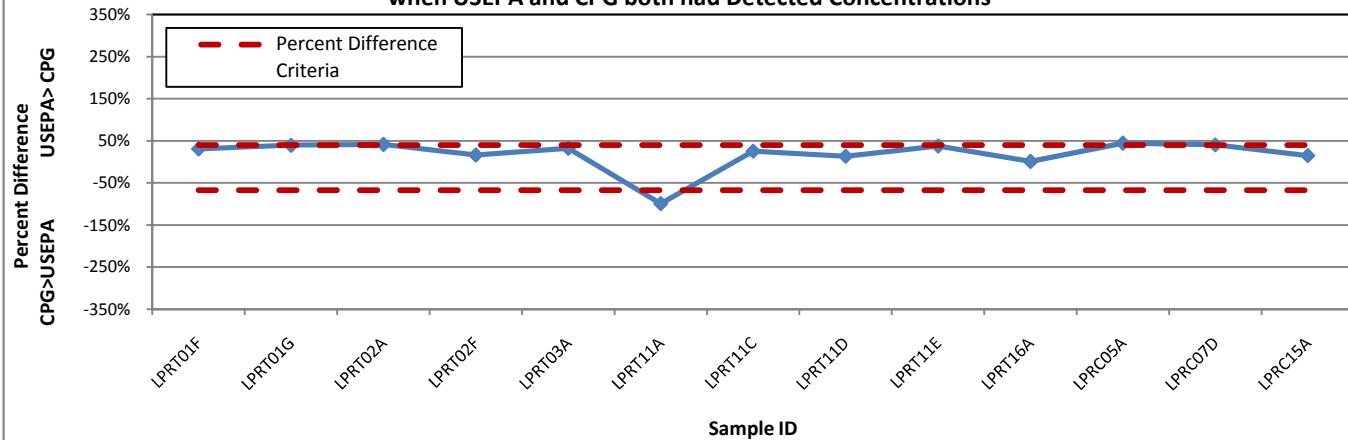


Figure 29a: Line Plot of 2,4'-DDD Concentrations

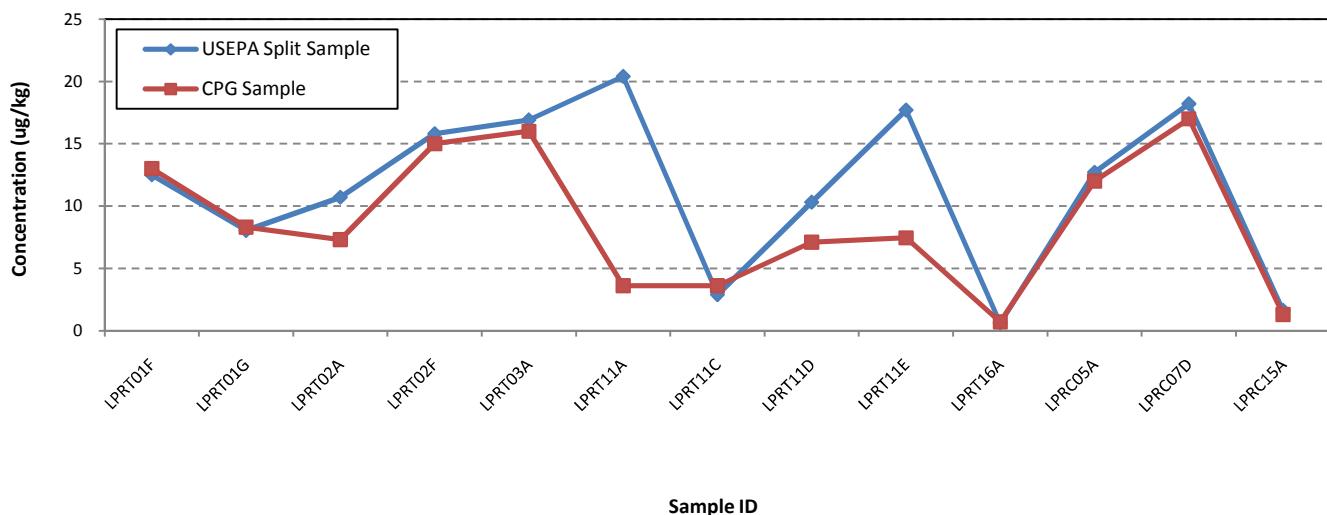


Figure 29b: Bivariate Plot of 2,4'-DDD Concentrations

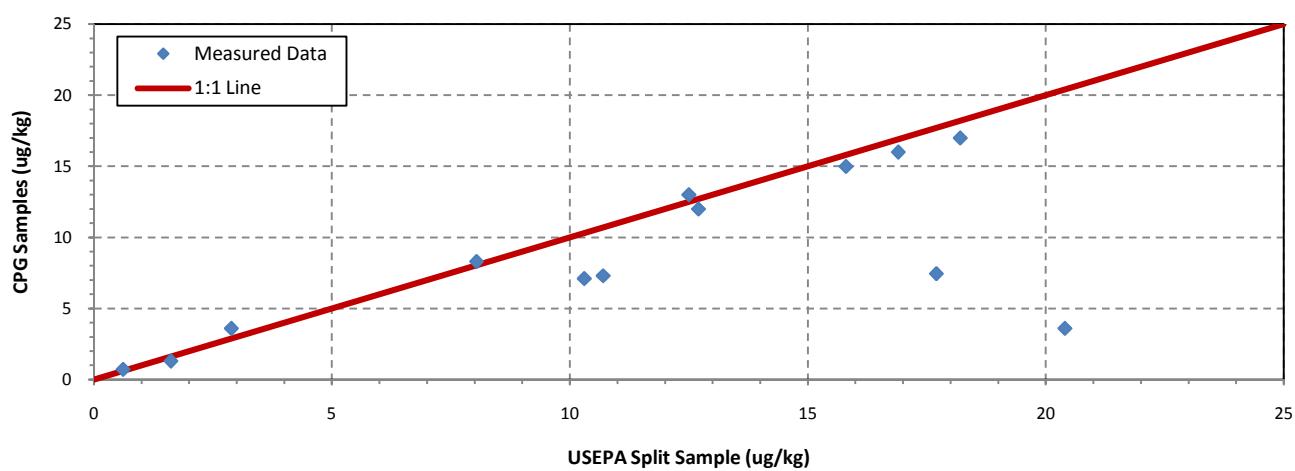


Figure 29c: Line Plot of 2,4'-DDD Percent Differences when USEPA and CPG both had Detected Concentrations

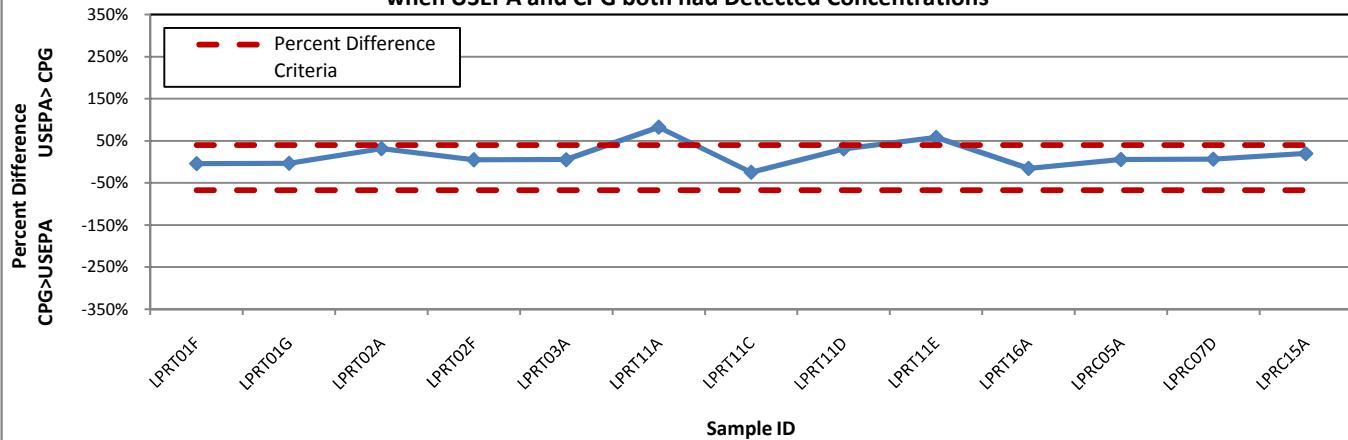


Figure 30a: Line Plot of 2,4'-DDE Concentrations

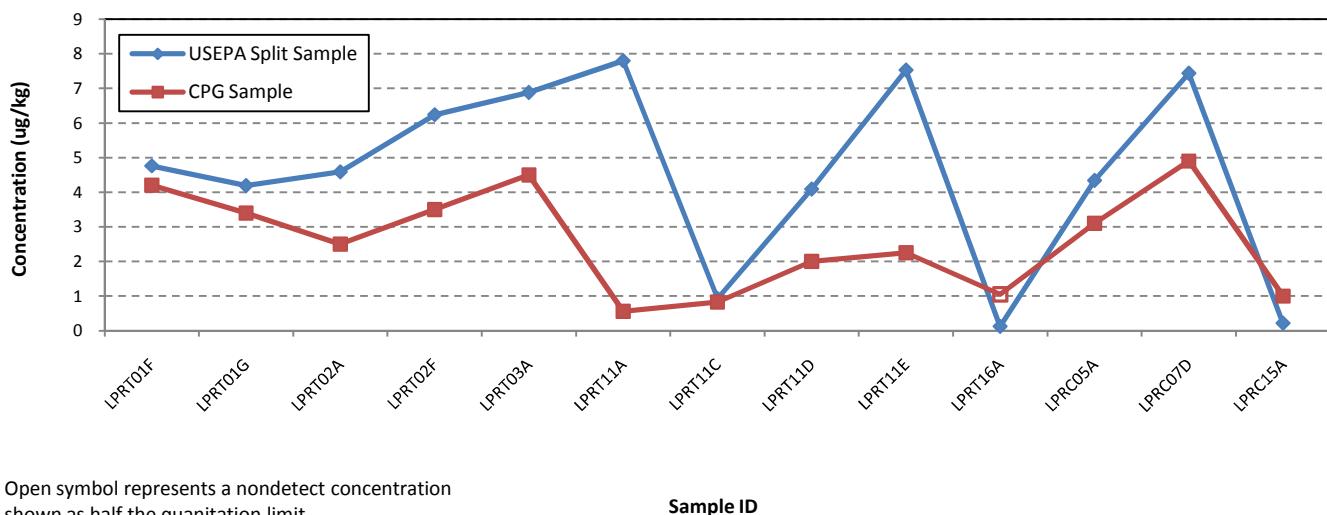


Figure 30b: Bivariate Plot of 2,4'-DDE Concentrations

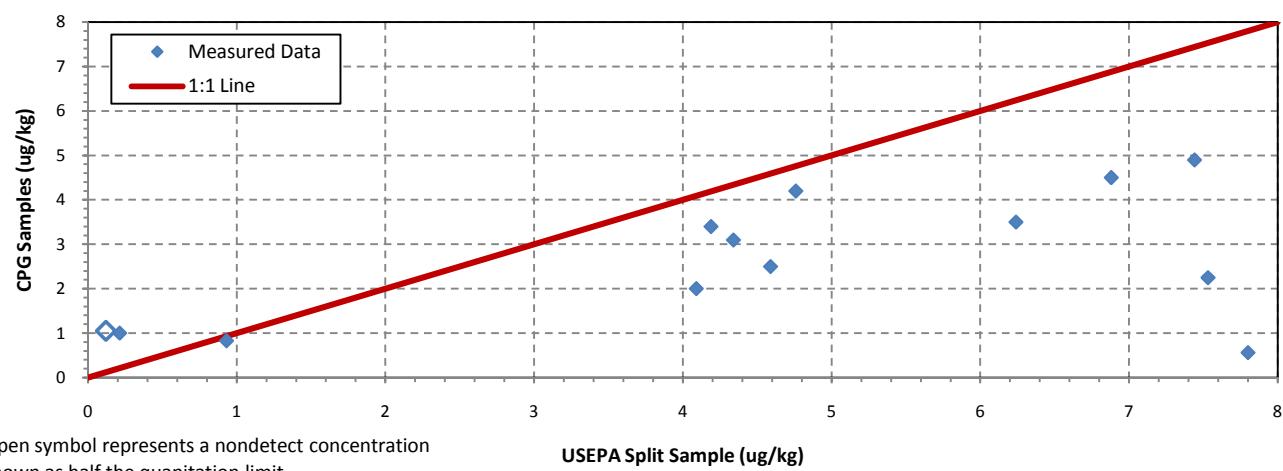


Figure 30c: Line Plot of 2,4'-DDE Percent Differences when USEPA and CPG both had Detected Concentrations

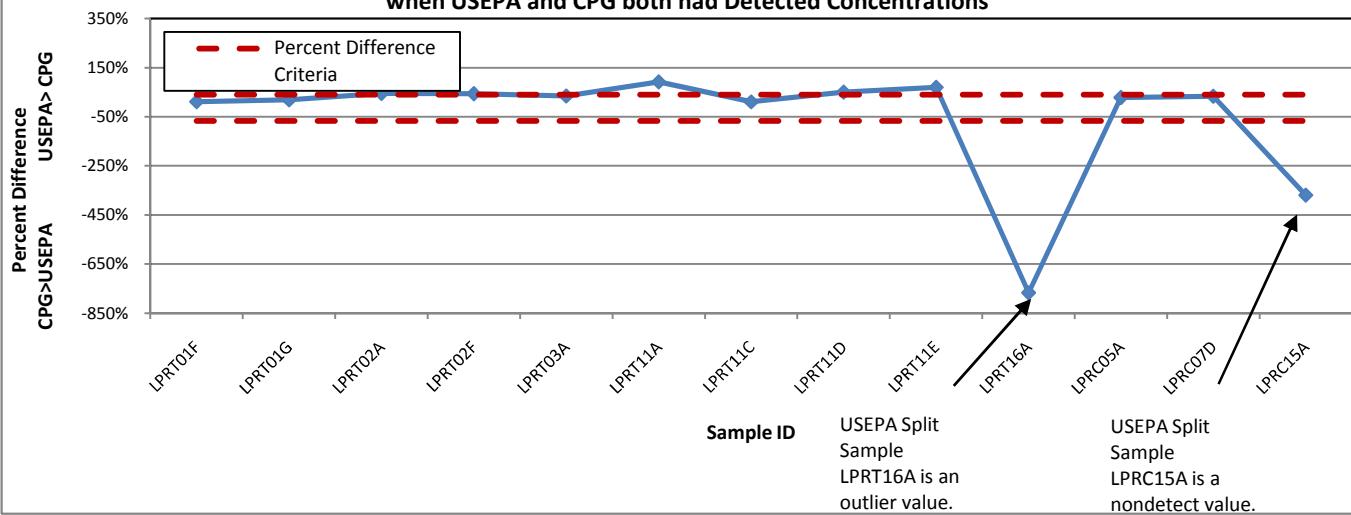


Figure 31a: Line Plot of 2,4'-DDT Concentrations

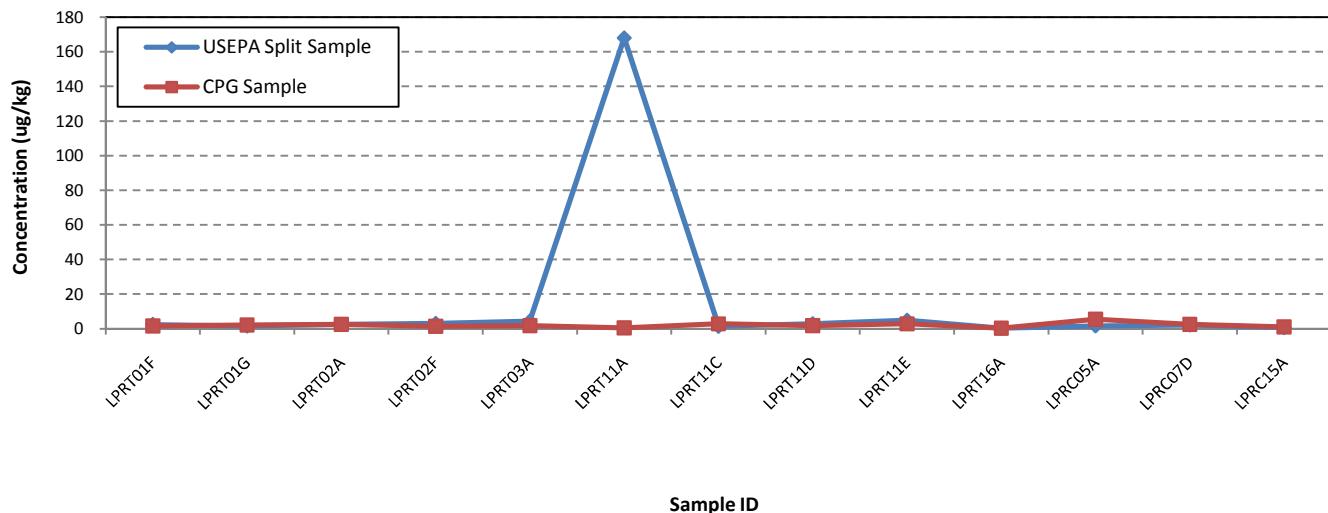


Figure 31b: Bivariate Plot of 2,4'-DDT Concentrations

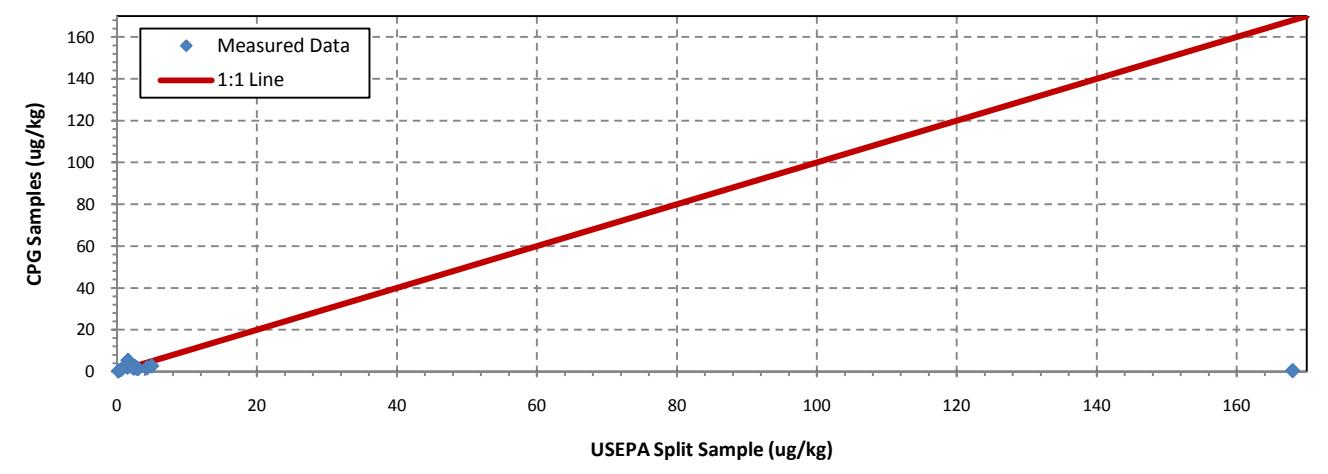


Figure 31c: Line Plot of 2,4'-DDT Percent Differences when USEPA and CPG both had Detected Concentrations

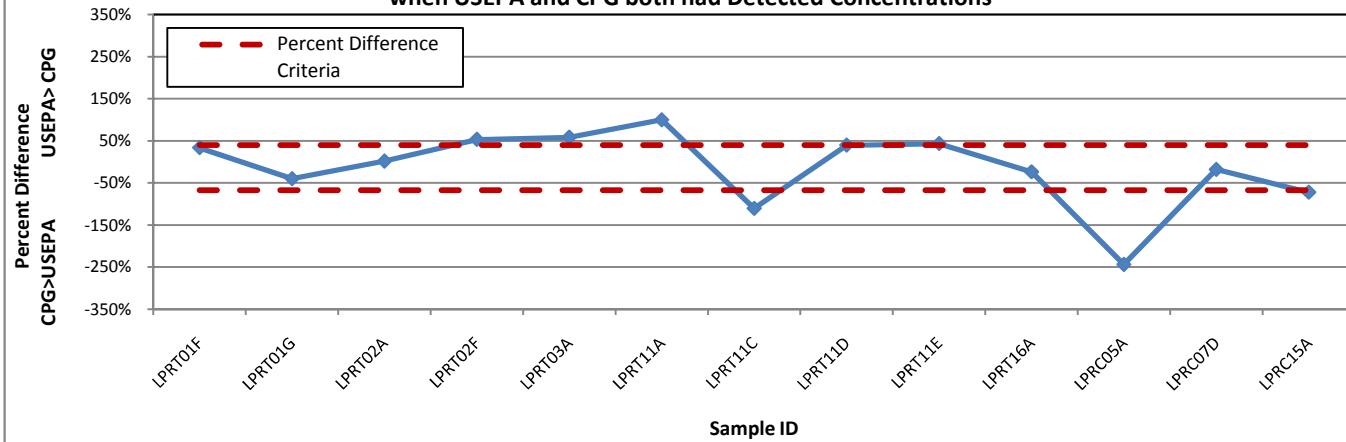


Figure 32a: Line Plot of 4,4'-DDD Concentrations

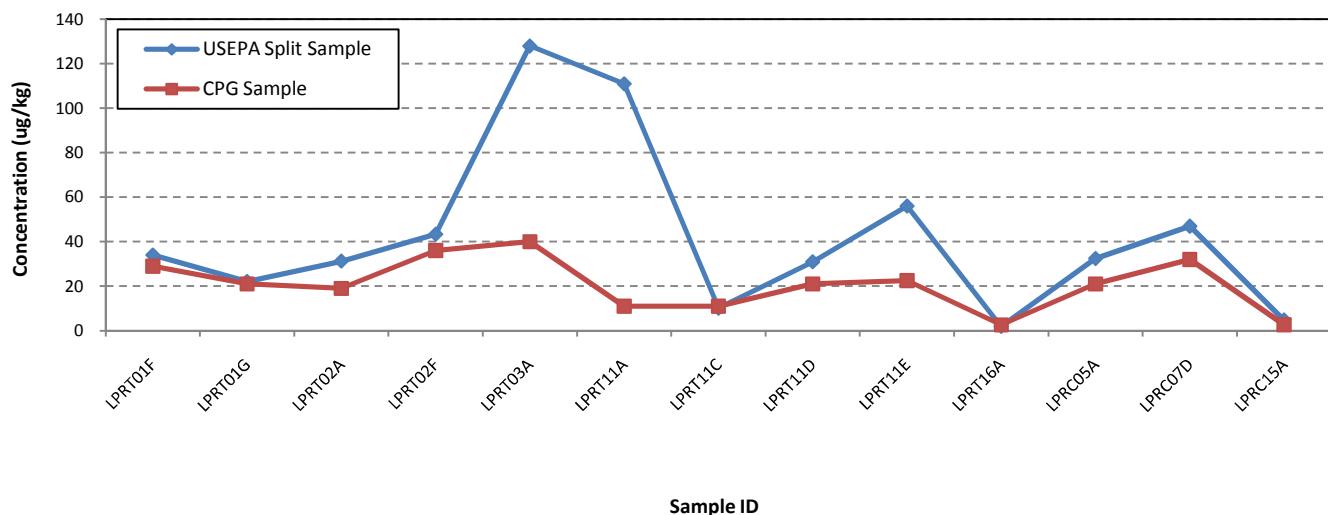


Figure 32b: Bivariate Plot of 4,4'-DDD Concentrations

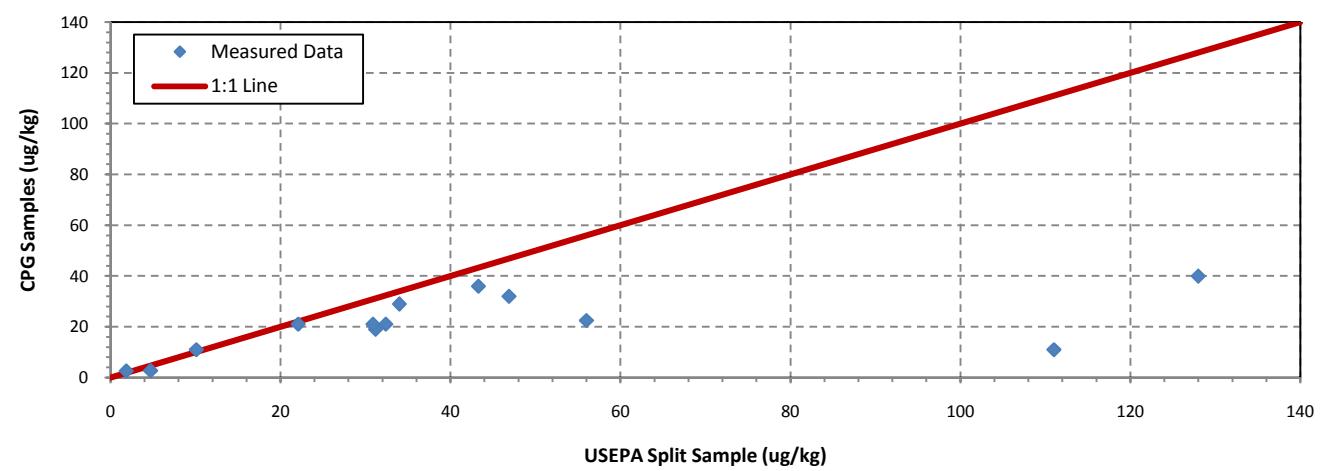


Figure 32c: Line Plot of 4,4'-DDD Percent Differences when USEPA and CPG both had Detected Concentrations

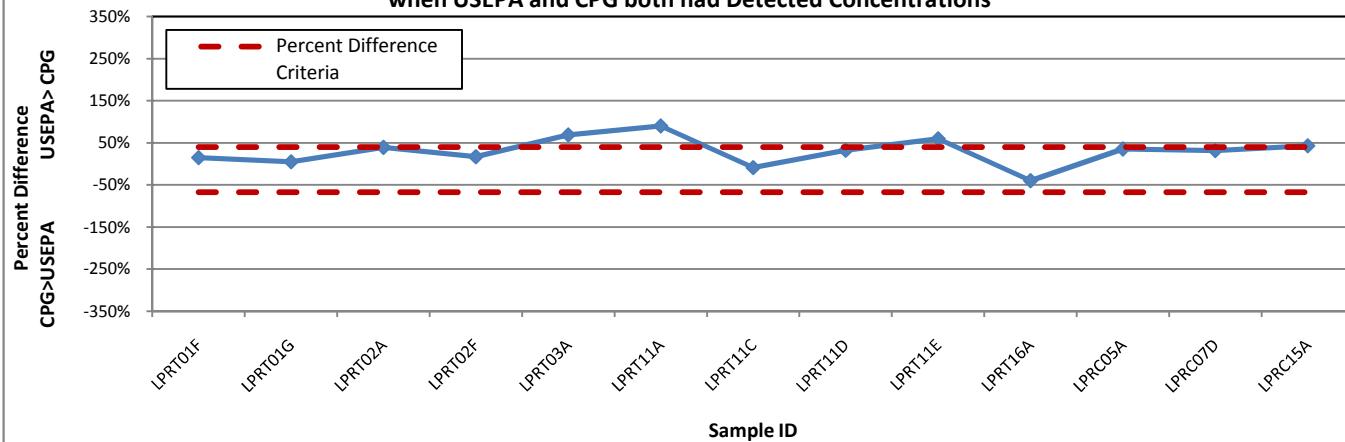


Figure 33a: Line Plot of 4,4'-DDE Concentrations



Figure 33b: Bivariate Plot of 4,4'-DDE Concentrations

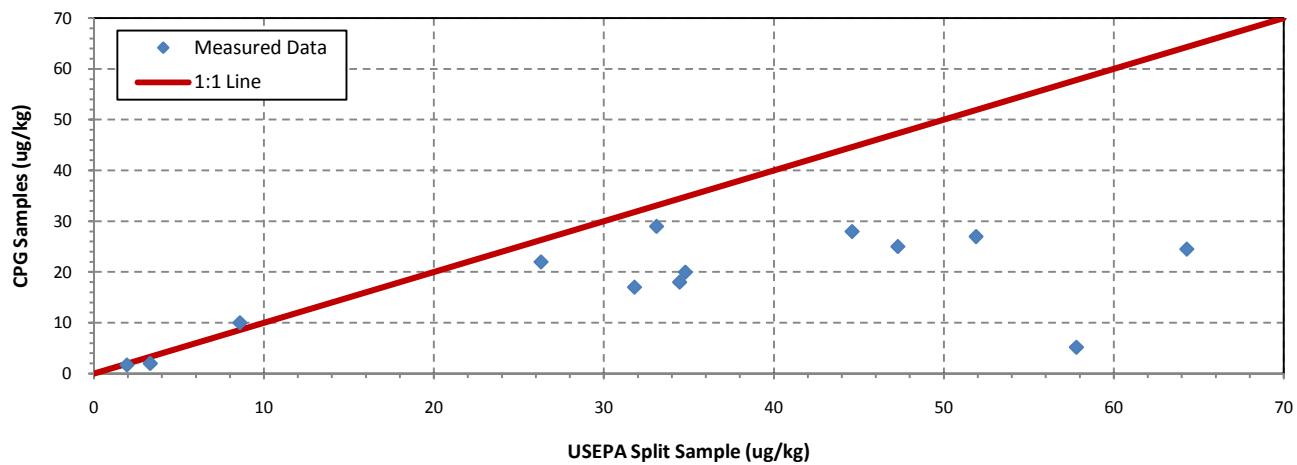


Figure 33c: Line Plot of 4,4'-DDE Percent Differences when USEPA and CPG both had Detected Concentrations

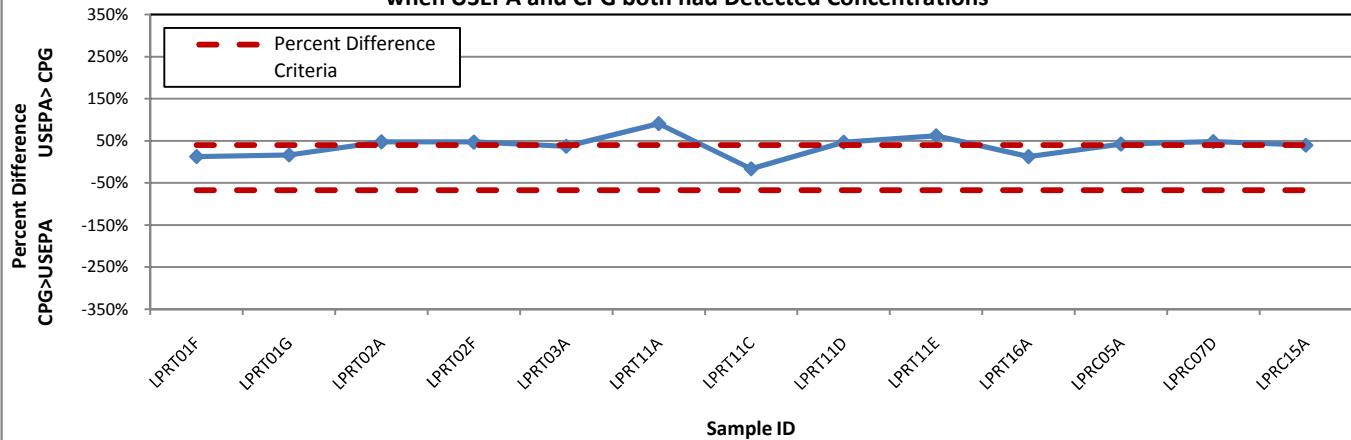


Figure 34a: Line Plot of 4,4'-DDT Concentrations

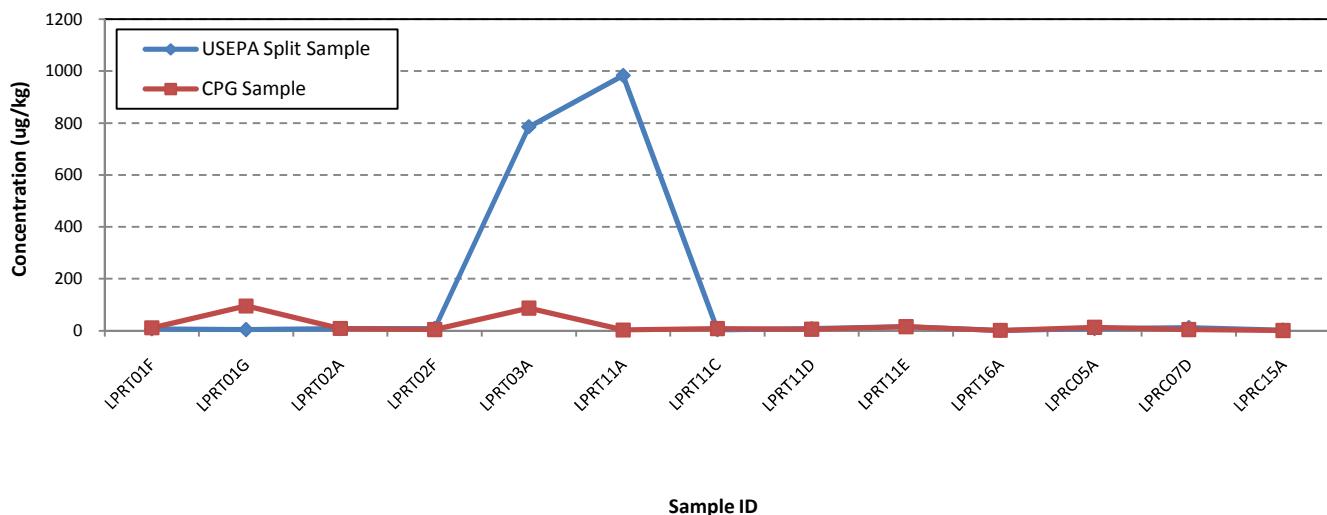


Figure 34b: Bivariate Plot of 4,4'-DDT Concentrations

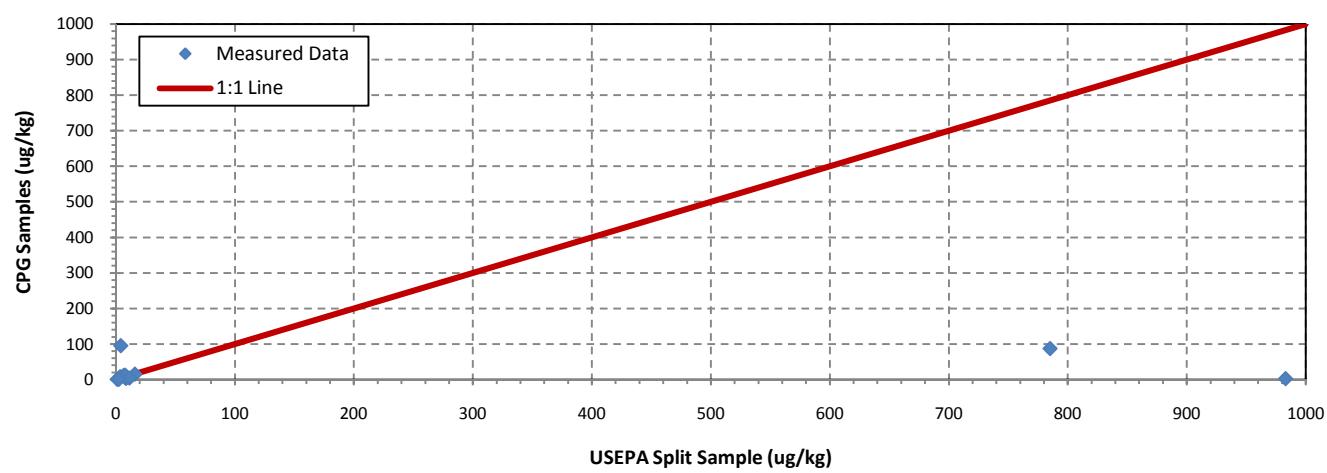


Figure 34c: Line Plot of 4,4'-DDT Percent Differences when USEPA and CPG both had Detected Concentrations

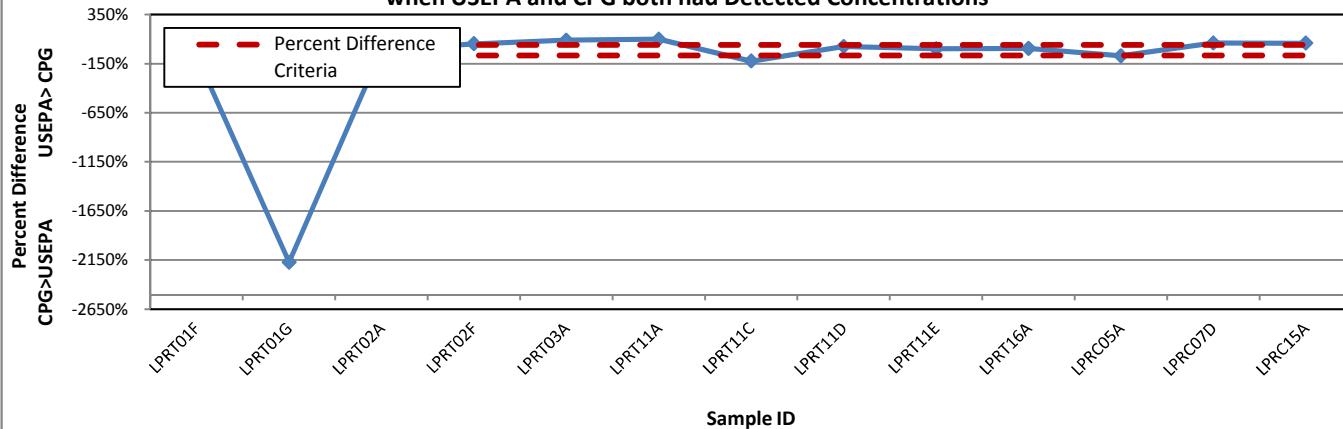


Figure 35a: Line Plot of Dieldrin Concentrations

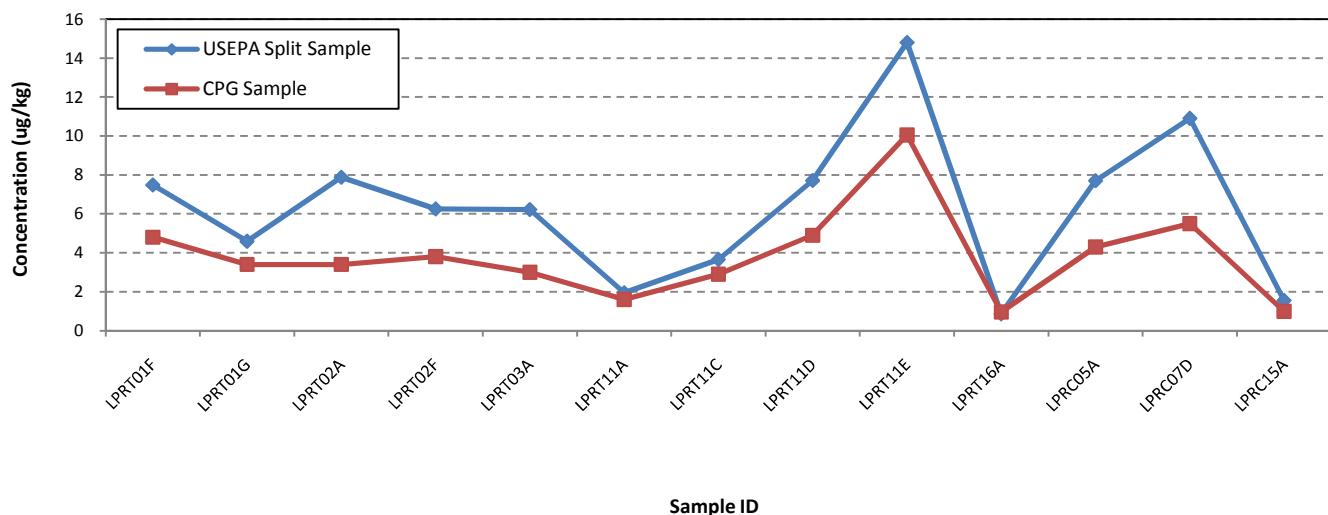


Figure 35b: Bivariate Plot of Dieldrin Concentrations

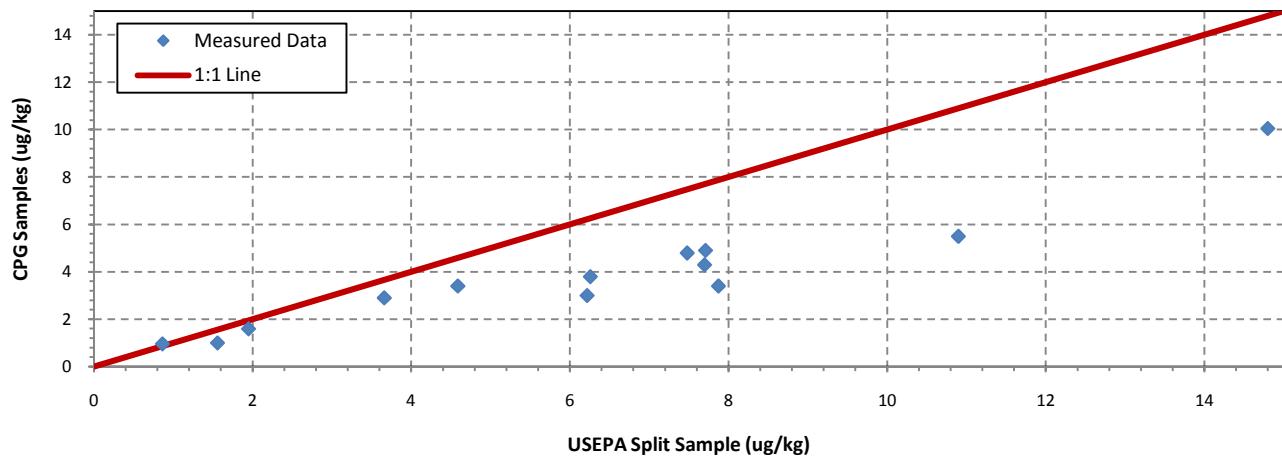


Figure 35c: Line Plot of Dieldrin Percent Differences when USEPA and CPG both had Detected Concentrations

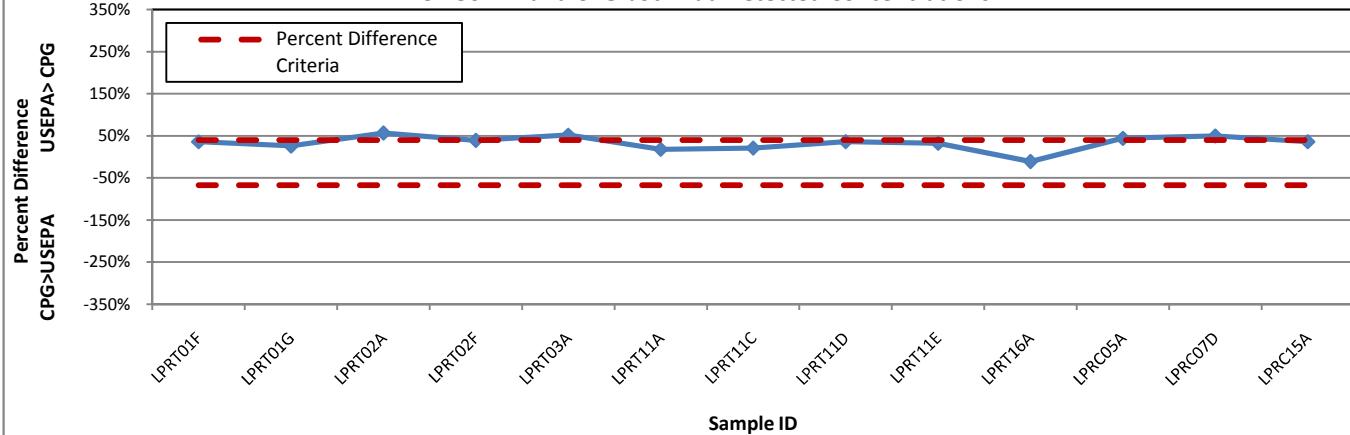


Figure 36a: Line Plot of gamma-Chlordane Concentrations

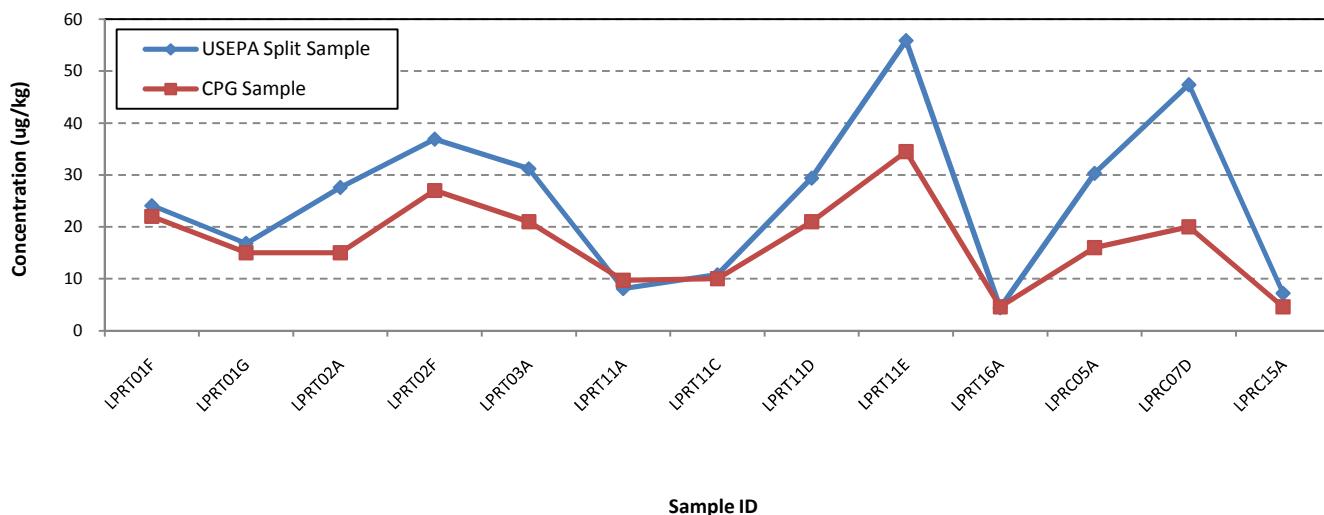


Figure 36b: Bivariate Plot of gamma-Chlordane Concentrations

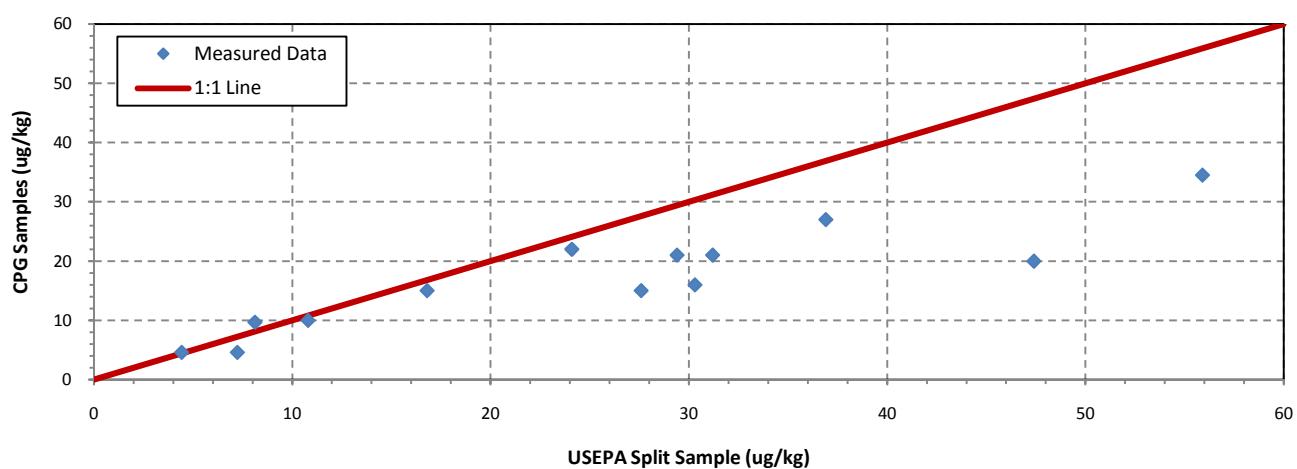


Figure 36c: Line Plot of gamma-Chlordane Percent Differences when USEPA and CPG both had Detected Concentrations

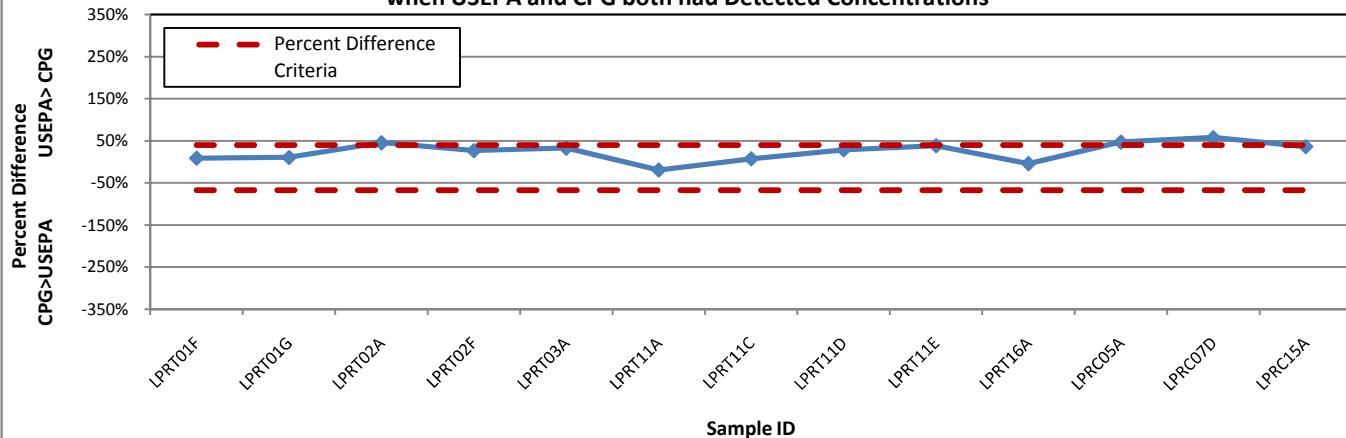


Figure 37a: Line Plot of Total Organic Carbon Concentrations

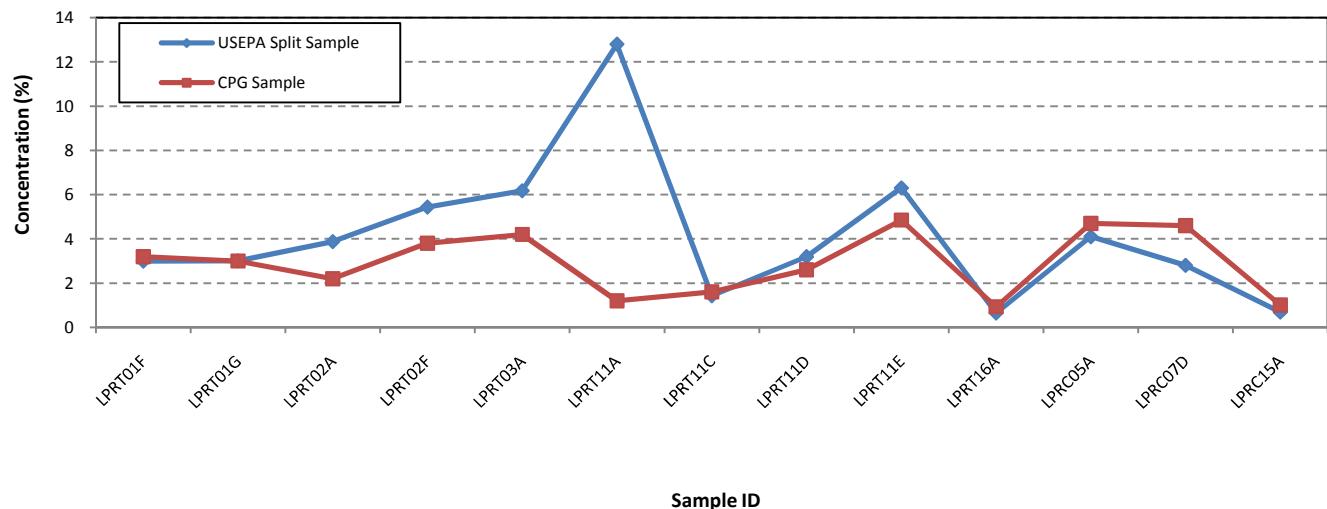


Figure 37b: Bivariate Plot of Total Organic Carbon Concentrations

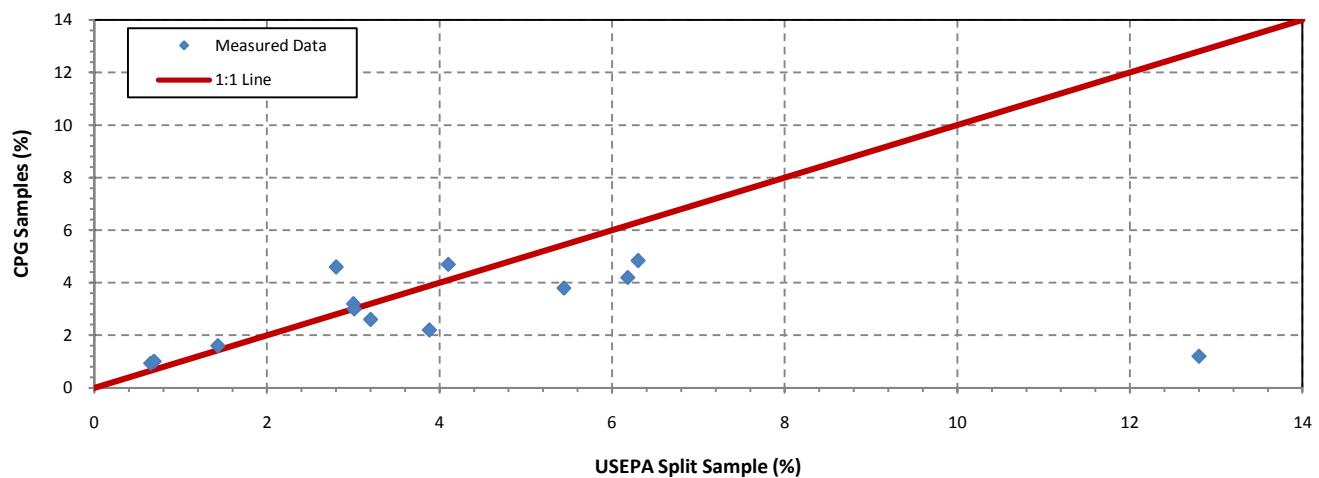


Figure 37c: Line Plot of Total Organic Carbon Percent Differences when USEPA and CPG both had Detected Concentrations

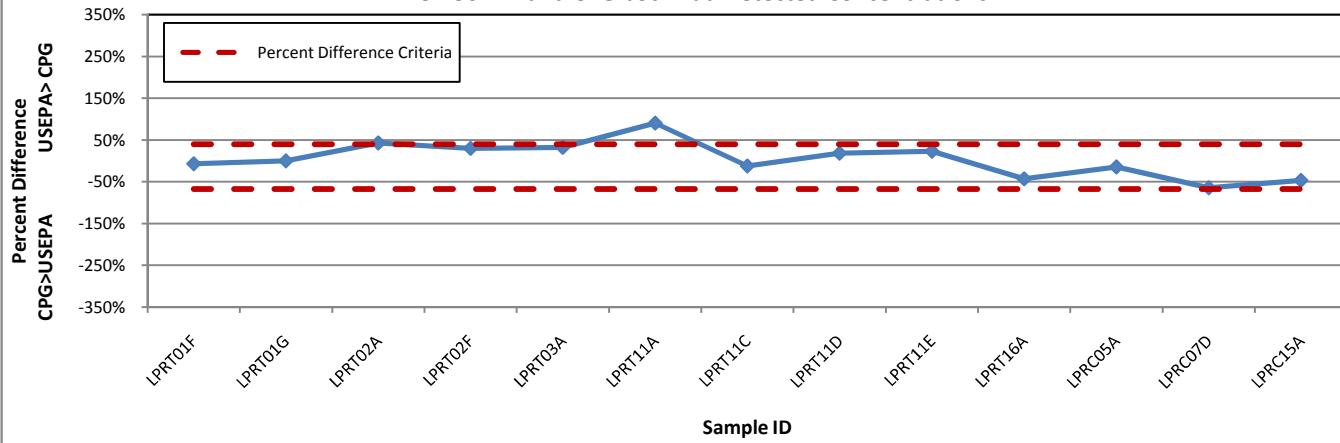


Figure 38a: Line Plot of Total PCB Concentrations

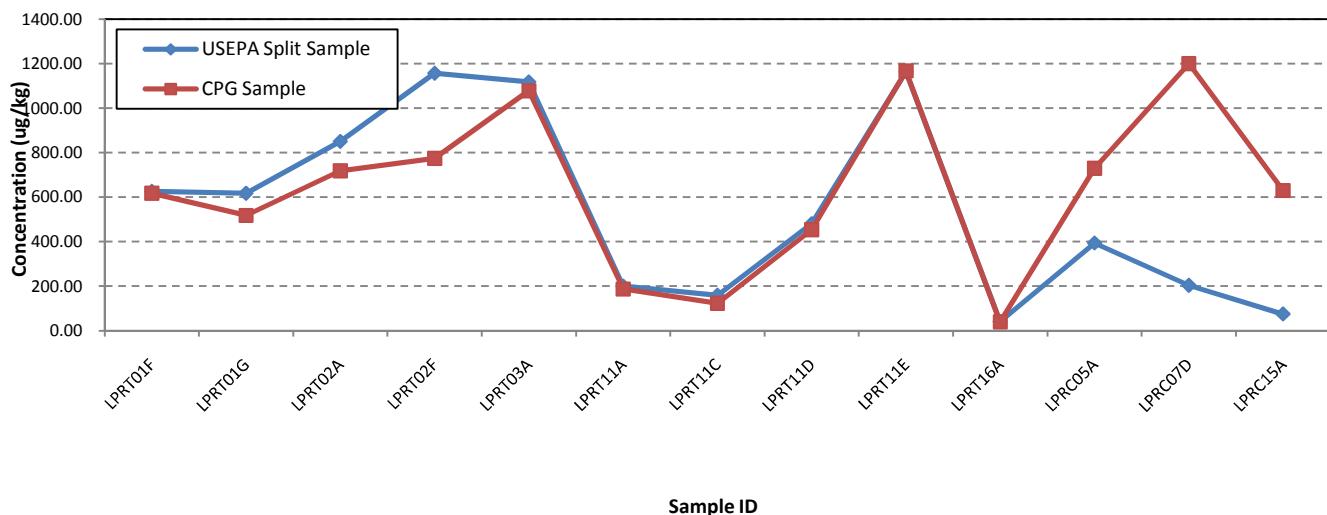


Figure 38b: Bivariate Plot of Total PCB Concentrations

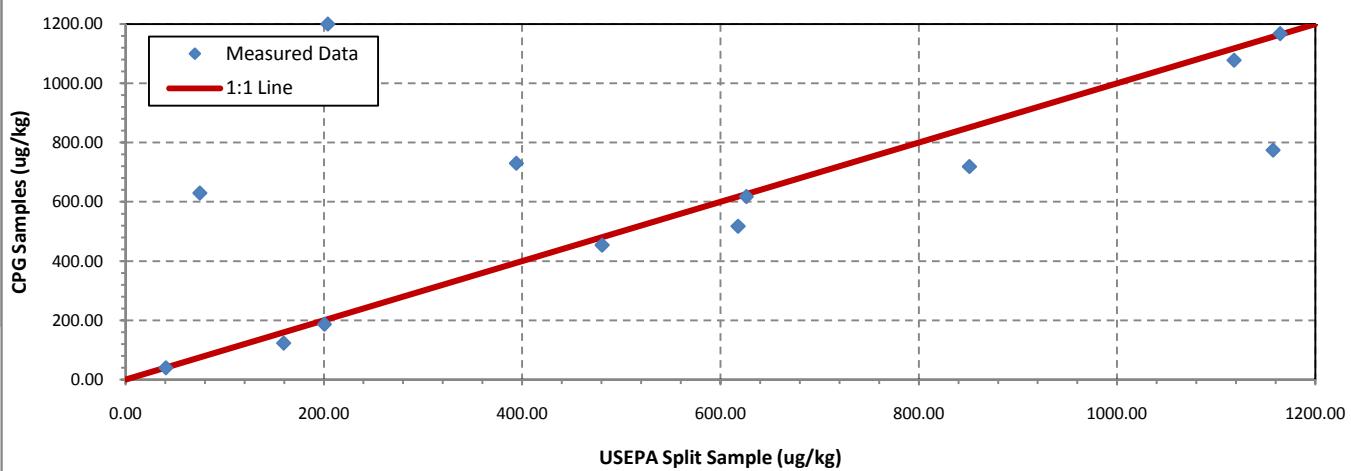


Figure 38c: Line Plot of Total PCB Percent Differences when USEPA and CPG both had Detected Concentrations

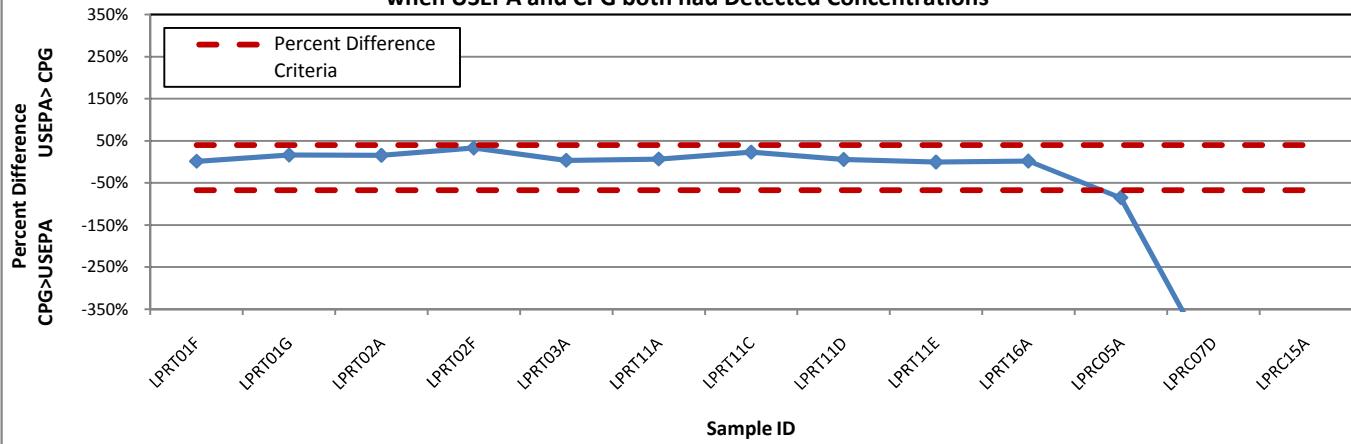


Figure 39a: Line Plot of 3,3',4,4'-Tetrachlorobiphenyl (BZ 77) Concentrations

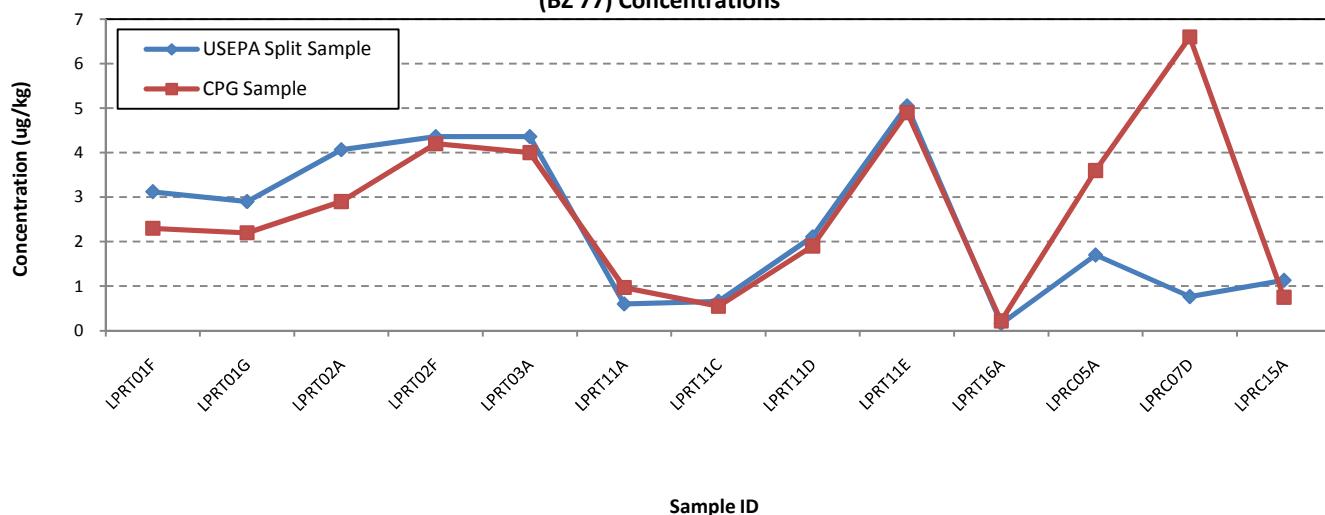


Figure 39b: Bivariate Plot of 3,3',4,4'-Tetrachlorobiphenyl (BZ 77) Concentrations

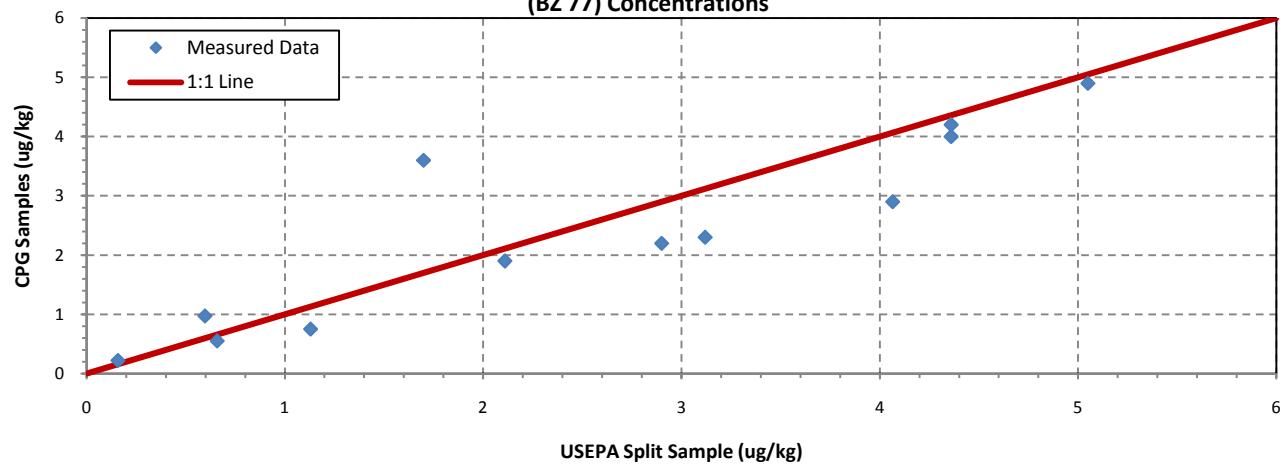


Figure 39c: Line Plot of 3,3',4,4'-Tetrachlorobiphenyl (BZ 77) Percent Differences when USEPA and CPG both had Detected Concentrations

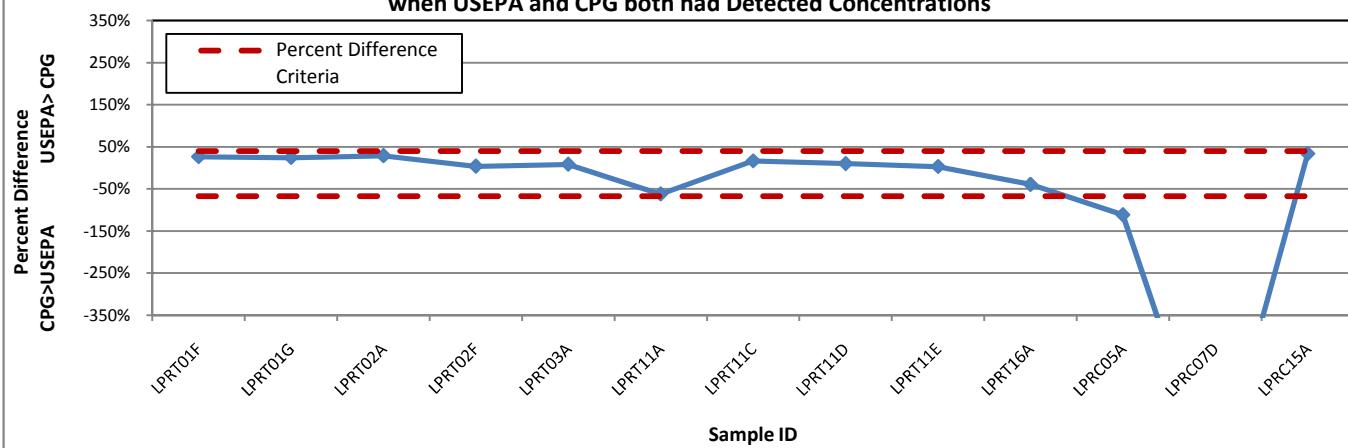
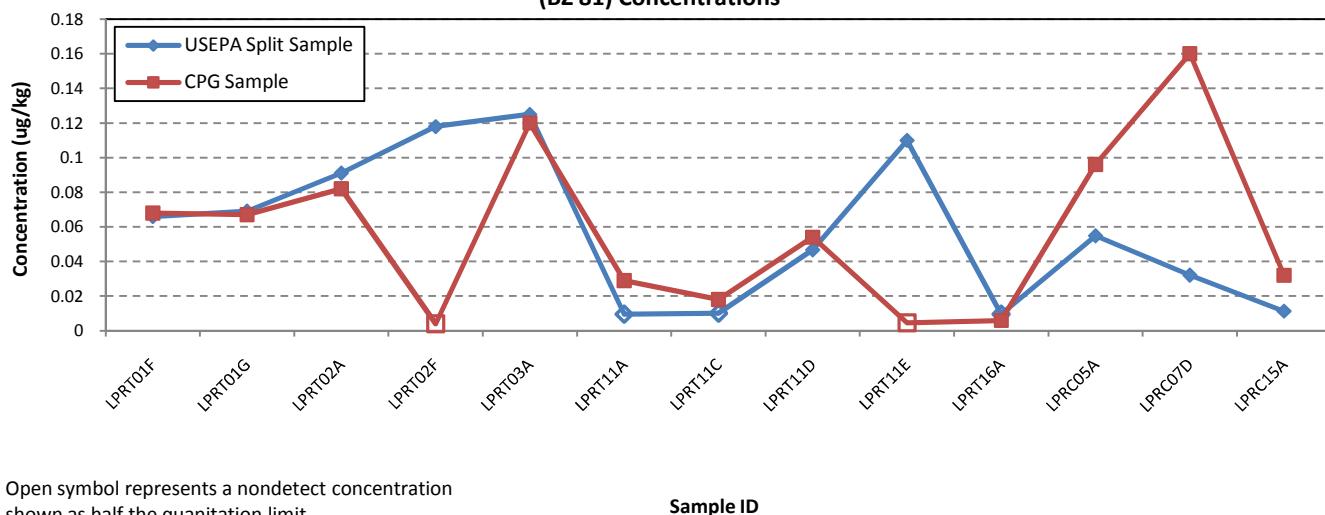
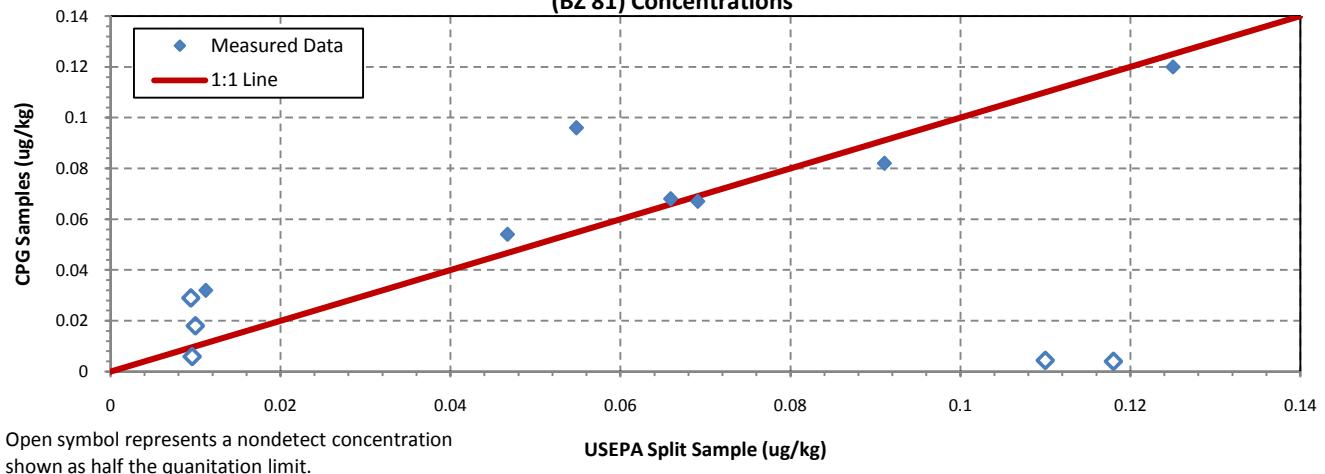


Figure 40a: Line Plot of 3,4,4',5-Tetrachlorobiphenyl (BZ 81) Concentrations



Open symbol represents a nondetect concentration shown as half the quantitation limit.

Figure 40b: Bivariate Plot of 3,4,4',5-Tetrachlorobiphenyl (BZ 81) Concentrations



Open symbol represents a nondetect concentration shown as half the quantitation limit.

Figure 40c: Line Plot of 3,4,4',5-Tetrachlorobiphenyl (BZ 81) Percent Differences when USEPA and CPG both had Detected Concentrations

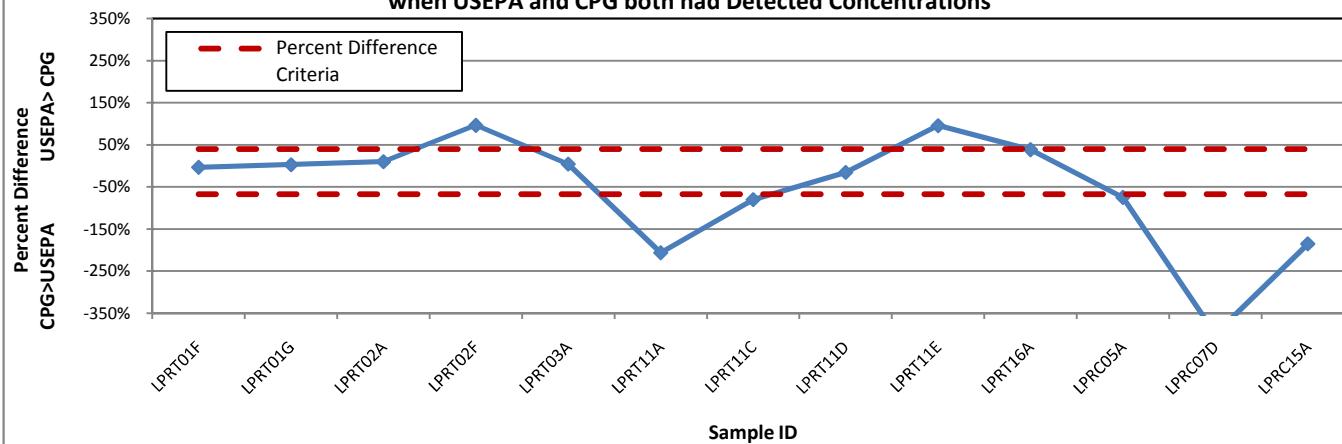


Figure 41a: Line Plot of 2,3,3',4,4'-Pentachlorobiphenyl (BZ 105) Concentrations

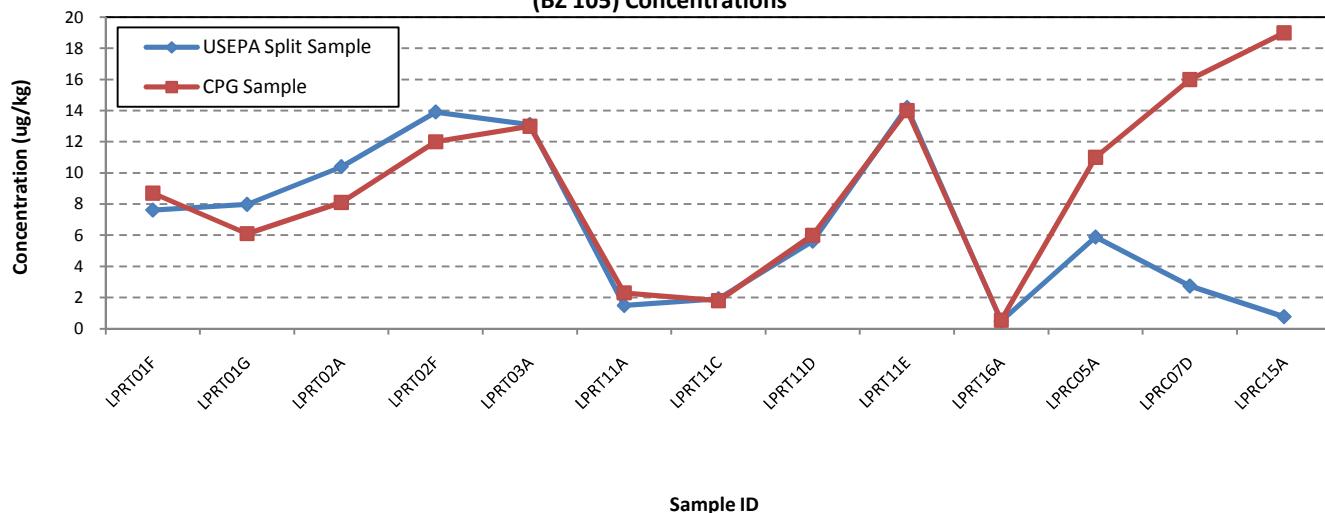


Figure 41b: Bivariate Plot of 2,3,3',4,4'-Pentachlorobiphenyl (BZ 105) Concentrations

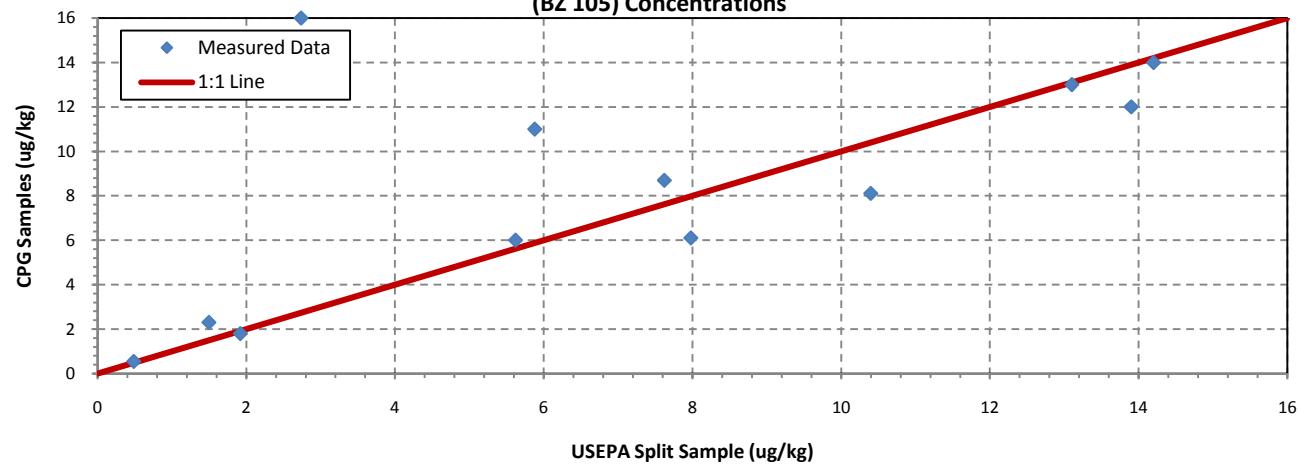


Figure 41c: Line Plot of 2,3,3',4,4'-Pentachlorobiphenyl (BZ 105) Percent Differences when USEPA and CPG both had Detected Concentrations

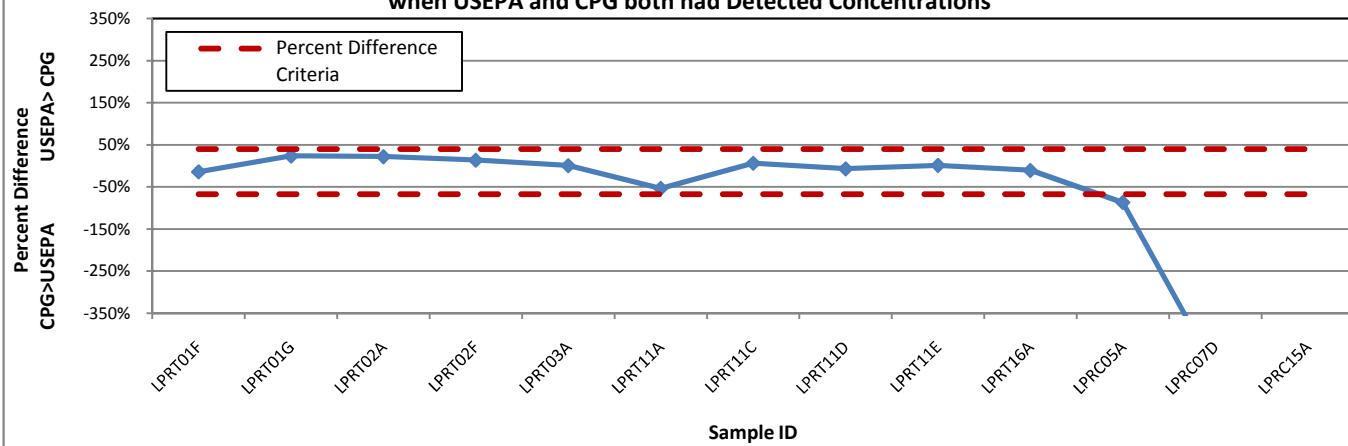


Figure 42a: Line Plot of 2,3,4,4',5-Pentachlorobiphenyl (BZ 114) Concentrations

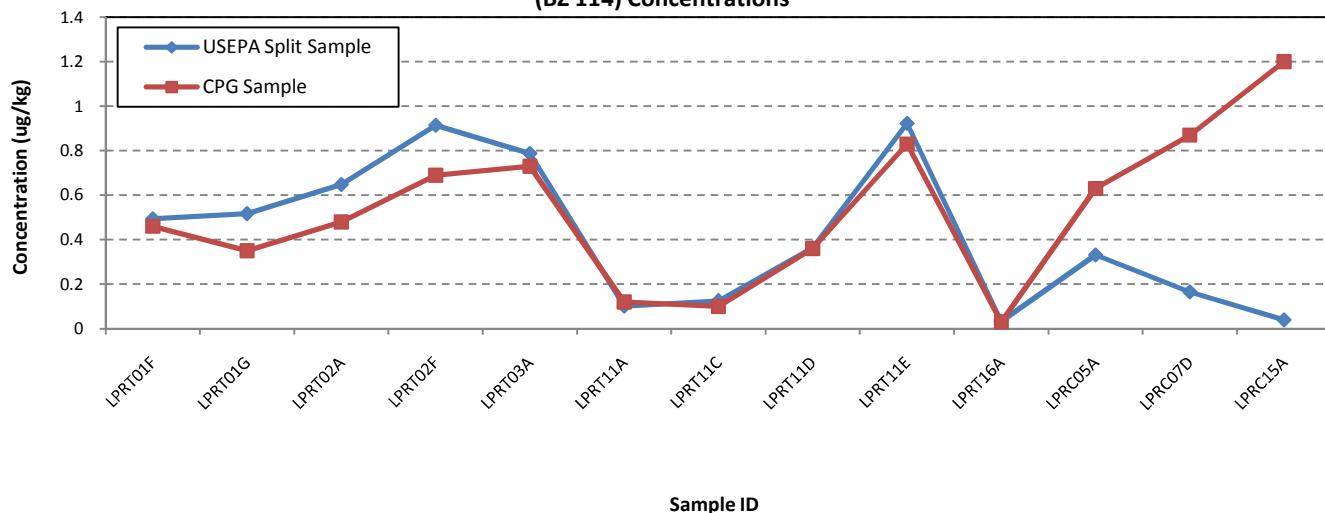


Figure 42b: Bivariate Plot of 2,3,4,4',5-Pentachlorobiphenyl (BZ 114) Concentrations

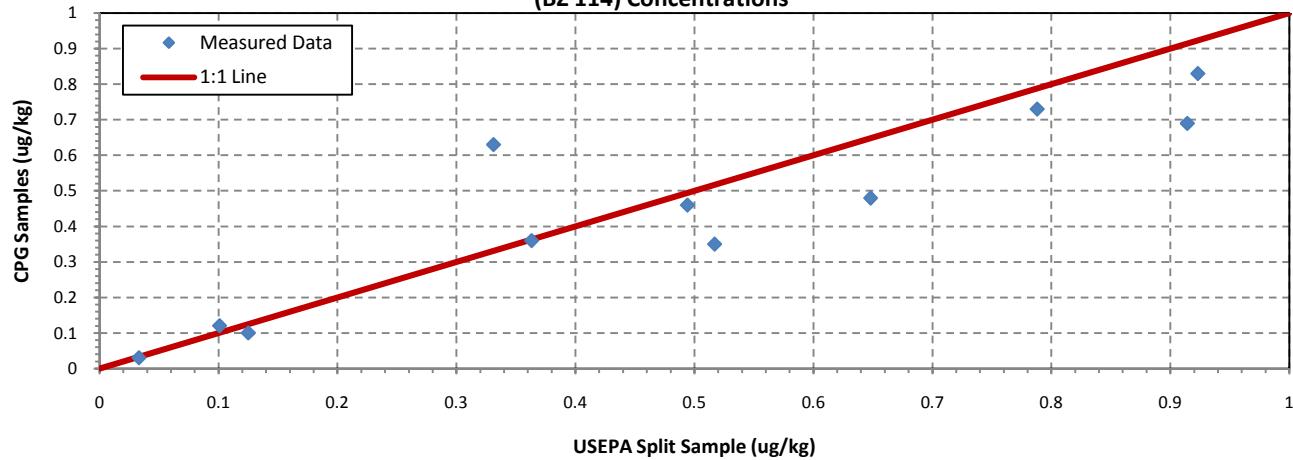


Figure 42c: Line Plot of 2,3,4,4',5-Pentachlorobiphenyl (BZ 114) Percent Differences when USEPA and CPG both had Detected Concentrations

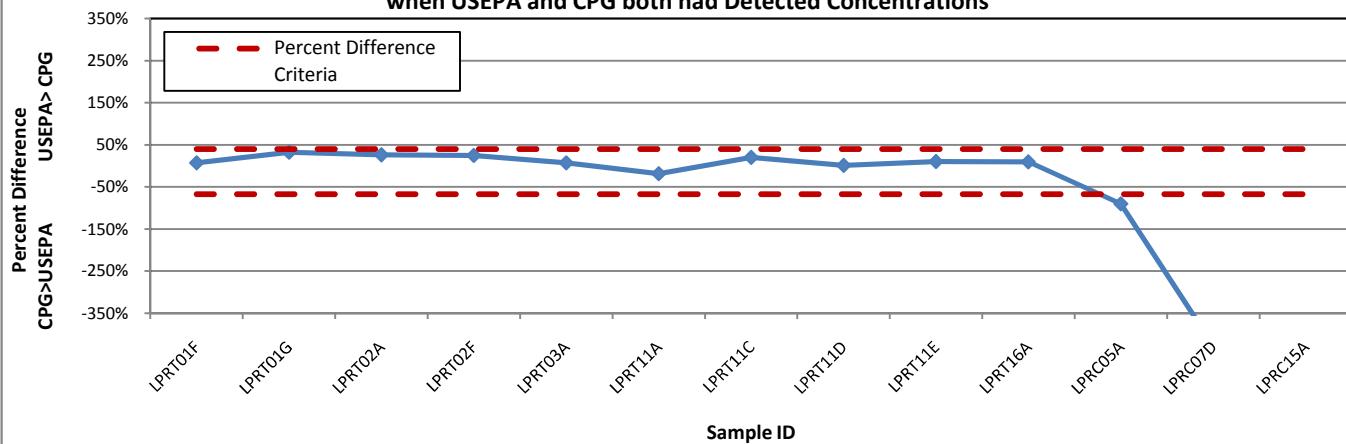


Figure 43a: Line Plot of 2,3',4,4',5-Pentachlorobiphenyl (BZ 118) Concentrations

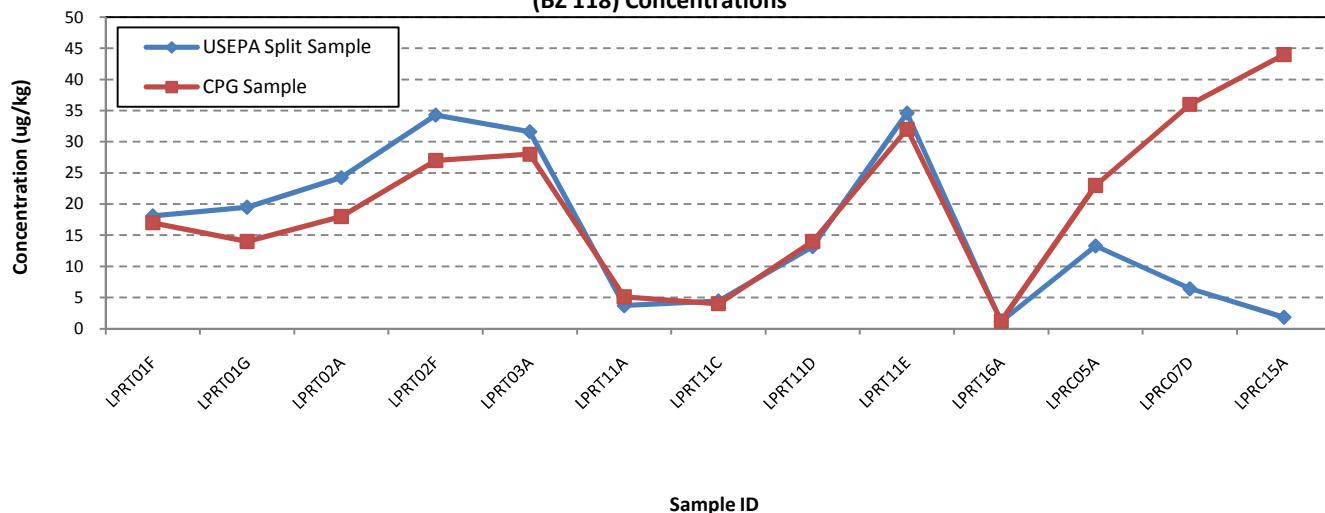


Figure 43b: Bivariate Plot of 2,3',4,4',5-Pentachlorobiphenyl (BZ 118) Concentrations

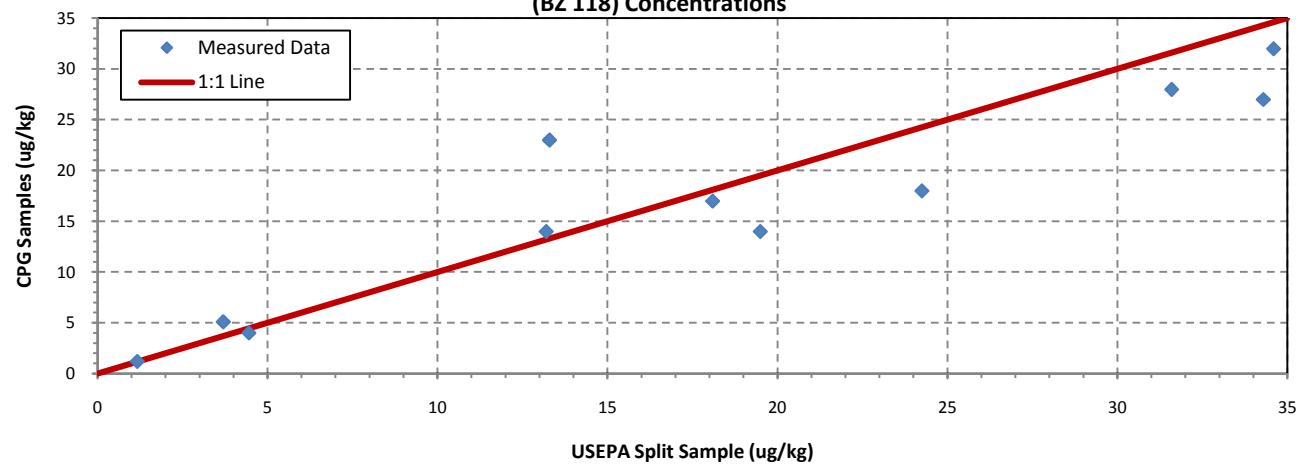


Figure 43c: Line Plot of 2,3',4,4',5-Pentachlorobiphenyl (BZ 118) Percent Differences when USEPA and CPG both had Detected Concentrations

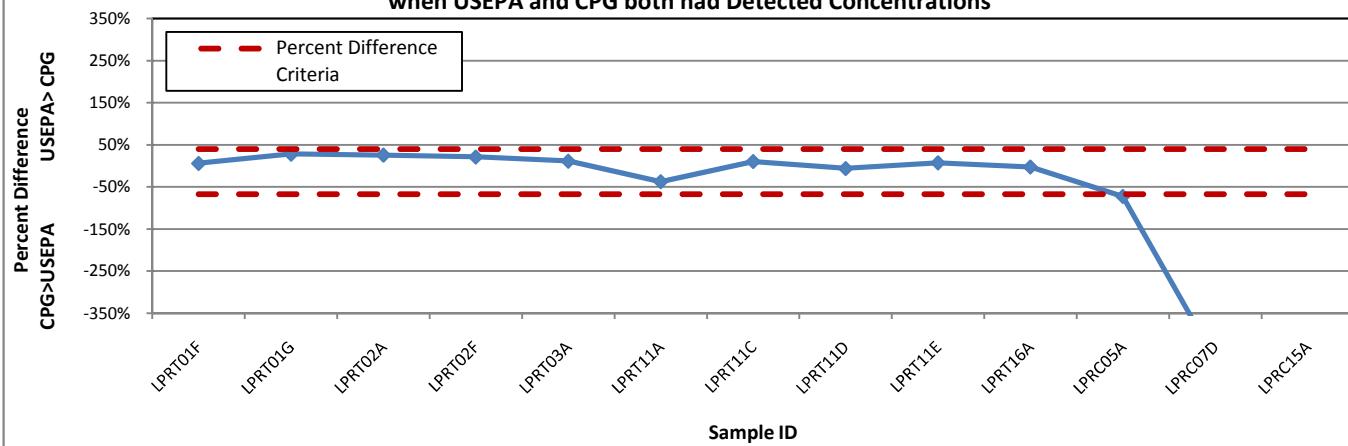


Figure 44a: Line Plot of 2,3',4,4',5'-Pentachlorobiphenyl (BZ 123) Concentrations

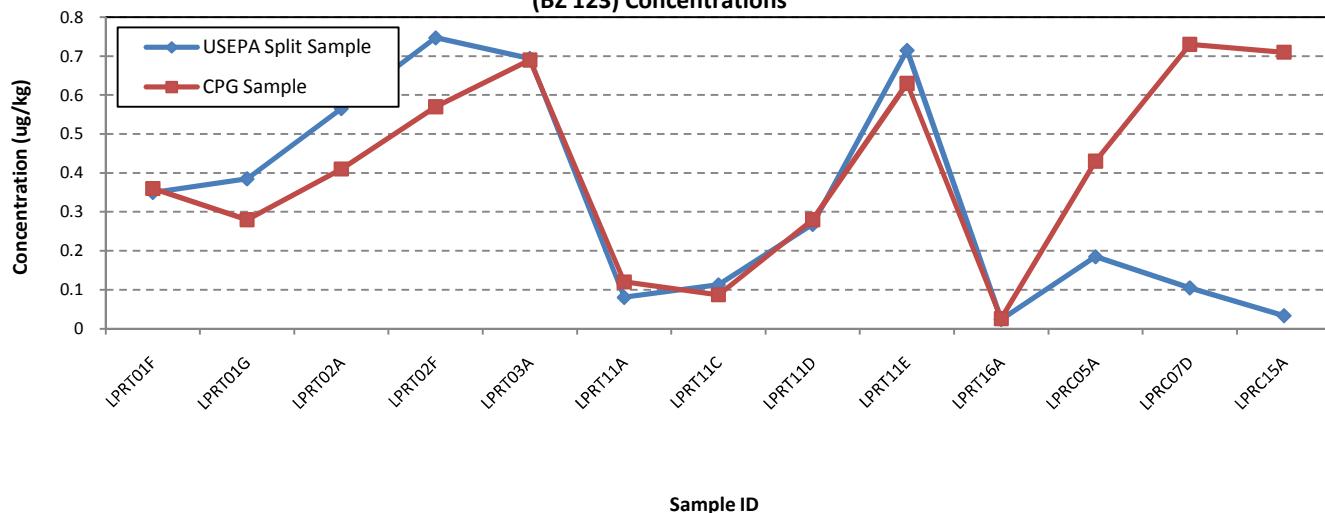


Figure 44b: Bivariate Plot of 2,3',4,4',5'-Pentachlorobiphenyl (BZ 123) Concentrations

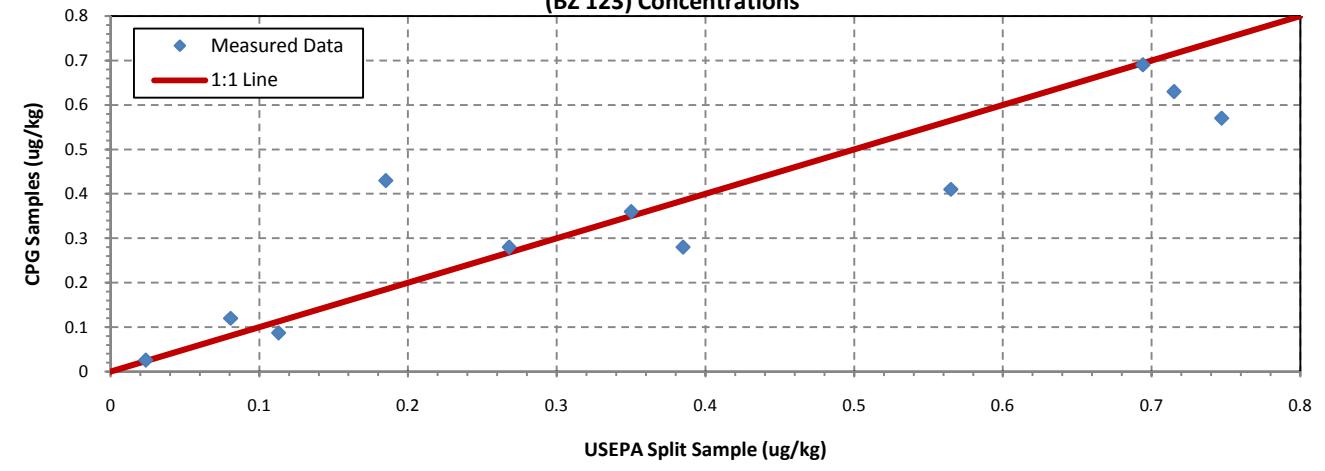


Figure 44c: Line Plot of 2,3',4,4',5'-Pentachlorobiphenyl (BZ 123) Percent Differences when USEPA and CPG both had Detected Concentrations

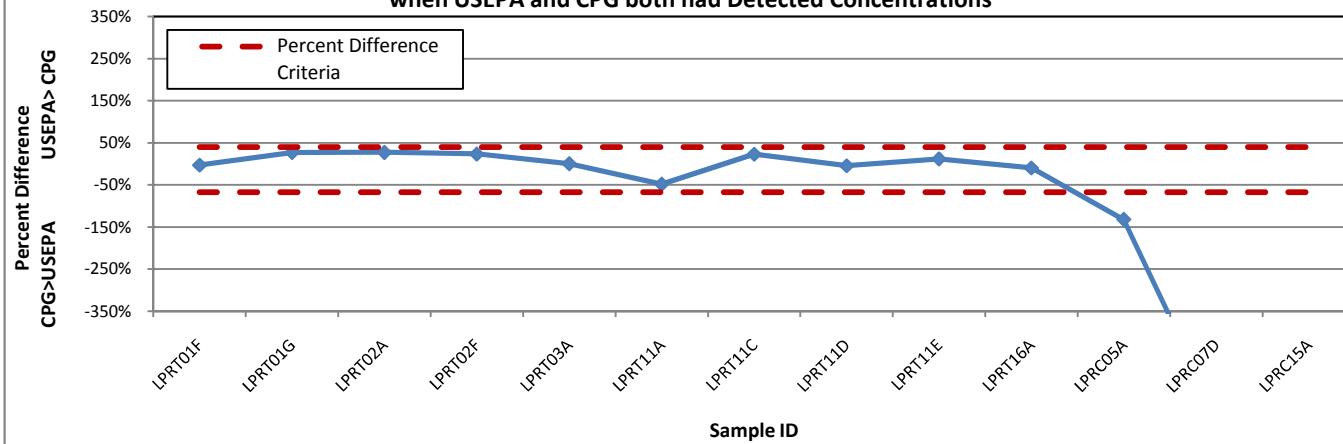


Figure 45a: Line Plot of 3,3',4,4',5-Pentachlorobiphenyl (BZ 126) Concentrations

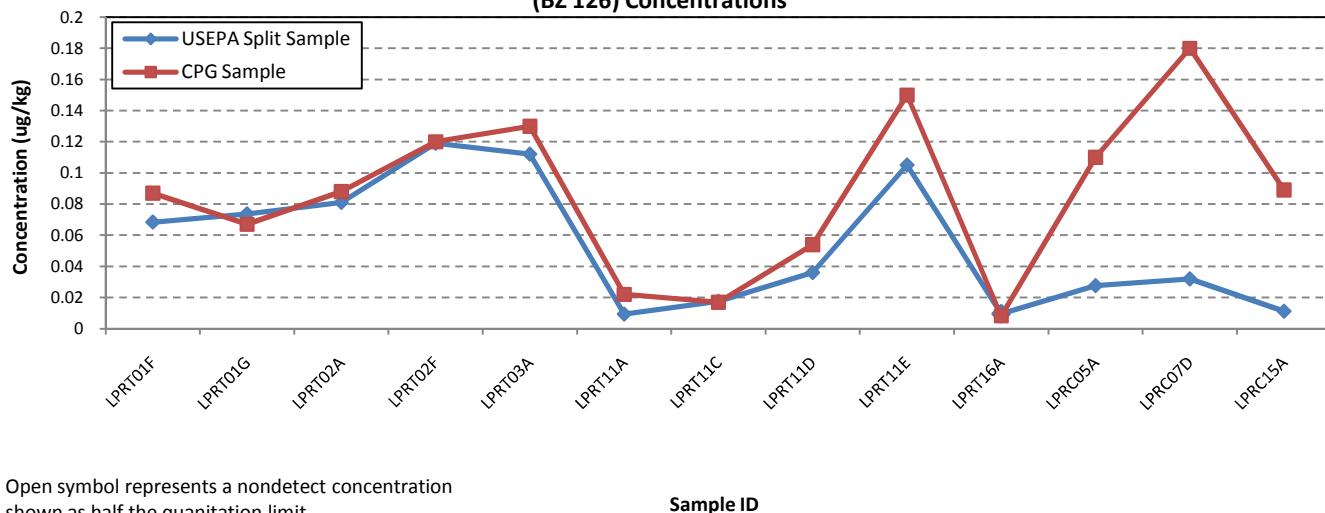


Figure 45b: Bivariate Plot of 3,3',4,4',5-Pentachlorobiphenyl (BZ 126) Concentrations

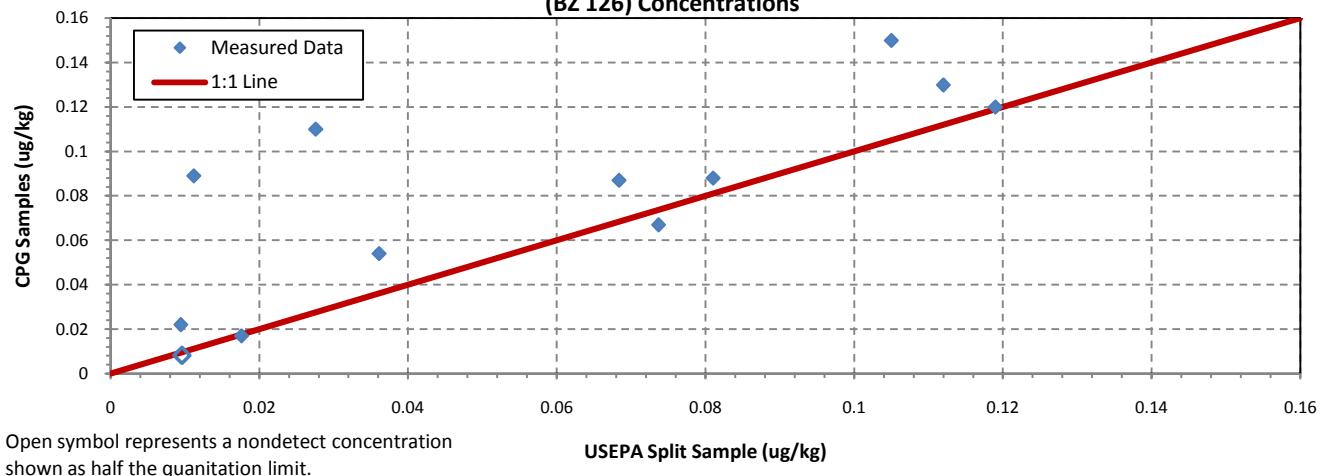


Figure 45c: Line Plot of 3,3',4,4',5-Pentachlorobiphenyl (BZ 126) Percent Differences when USEPA and CPG both had Detected Concentrations

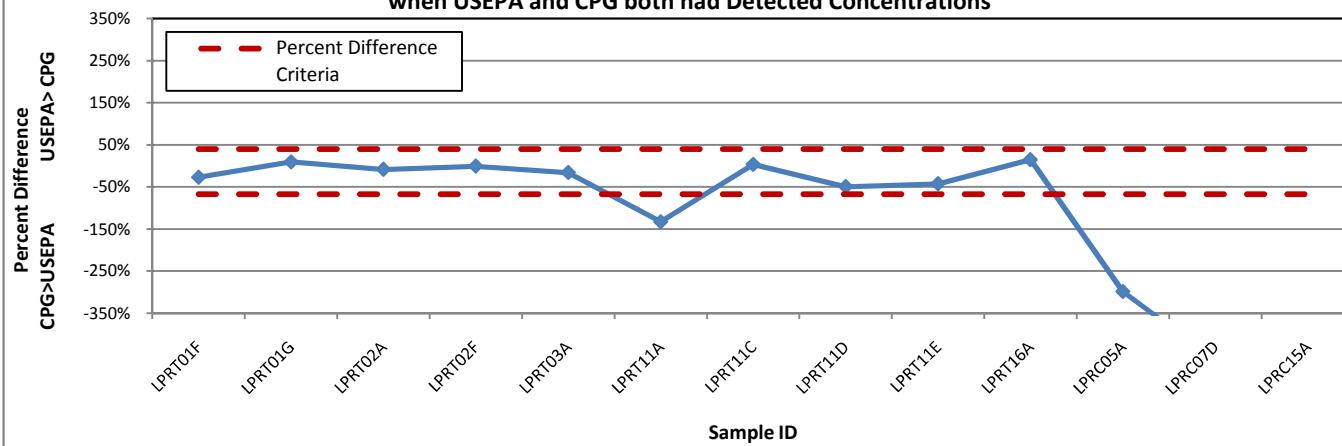


Figure 46a: Line Plot of 2,3,3',4,4',5-Hexachlorobiphenyl + 2,3,3',4,4',5'-Hexachlorobiphenyl (BZ 156 + BZ 157) Concentrations

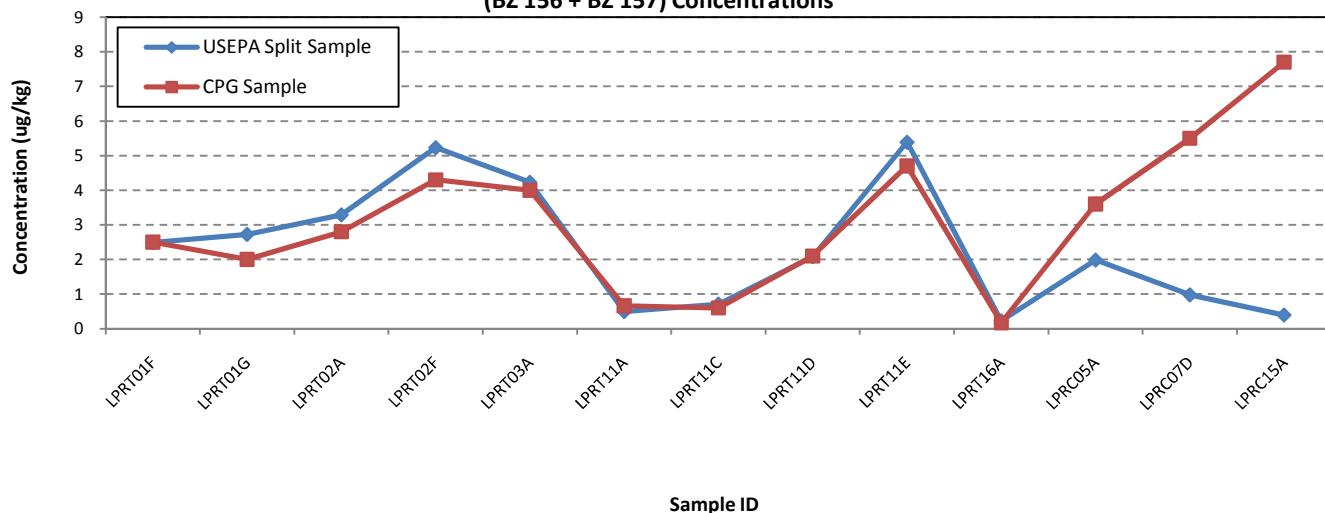


Figure 46b: Bivariate Plot of 2,3,3',4,4',5-Hexachlorobiphenyl + 2,3,3',4,4',5'-Hexachlorobiphenyl (BZ 156 + BZ 157) Concentrations

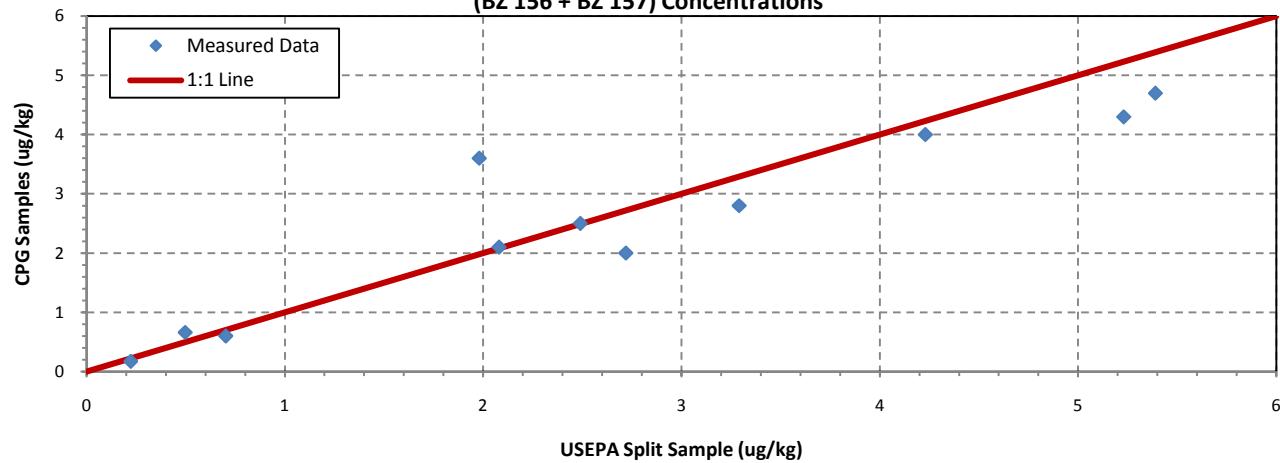


Figure 46c: Line Plot of 2,3,3',4,4',5-Hexachlorobiphenyl + 2,3,3',4,4',5'-Hexachlorobiphenyl (BZ 156 + BZ 157) Percent Differences when USEPA and CPG both had Detected Concentrations

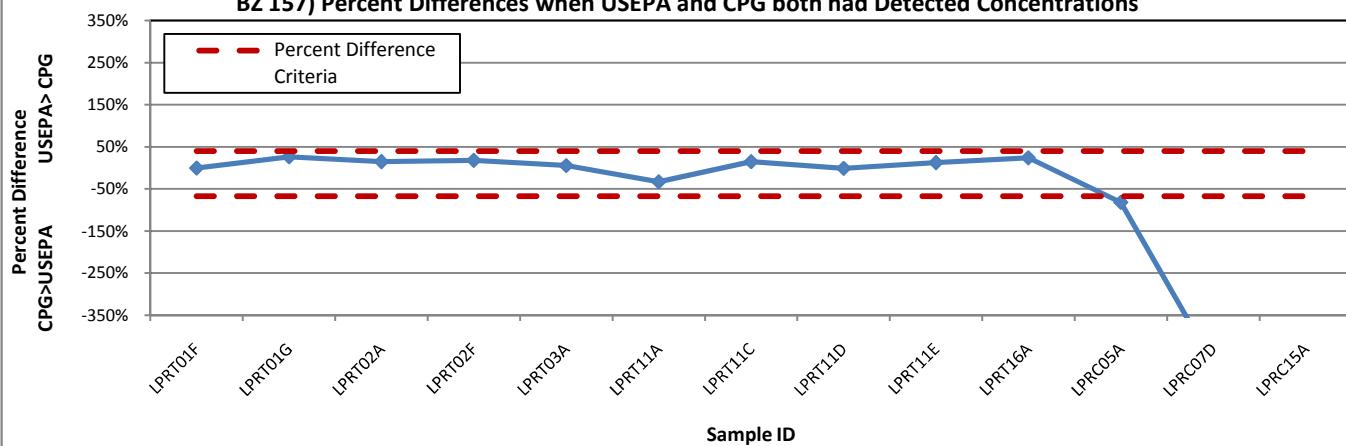


Figure 47a: Line Plot of 2,3',4,4',5,5'-Hexachlorobiphenyl (BZ 167) Concentrations

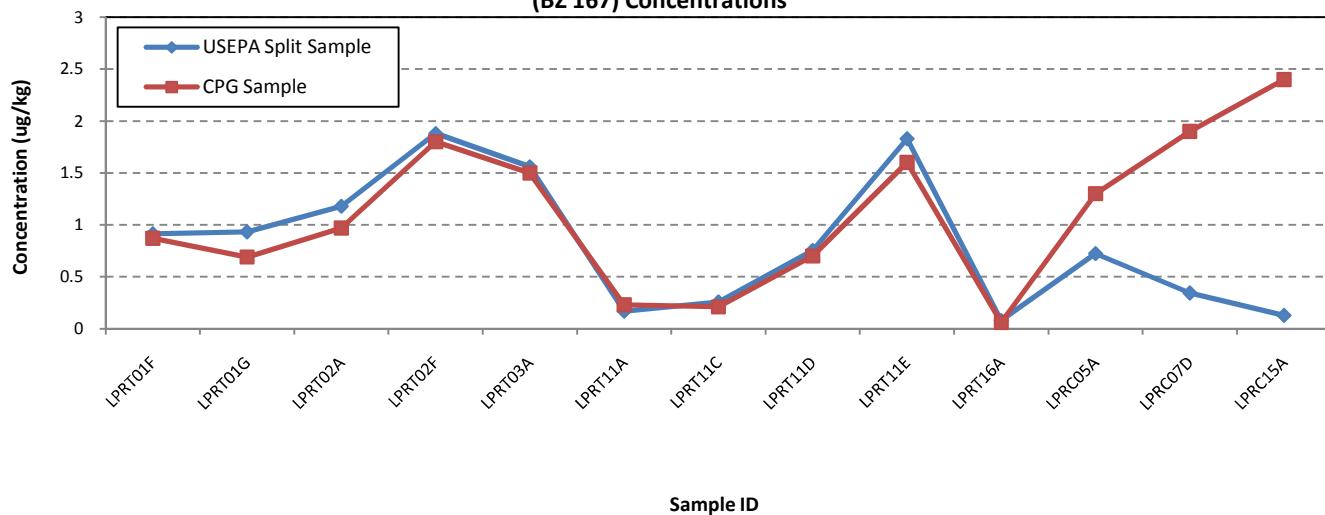


Figure 47b: Bivariate Plot of 2,3',4,4',5,5'-Hexachlorobiphenyl (BZ 167) Concentrations

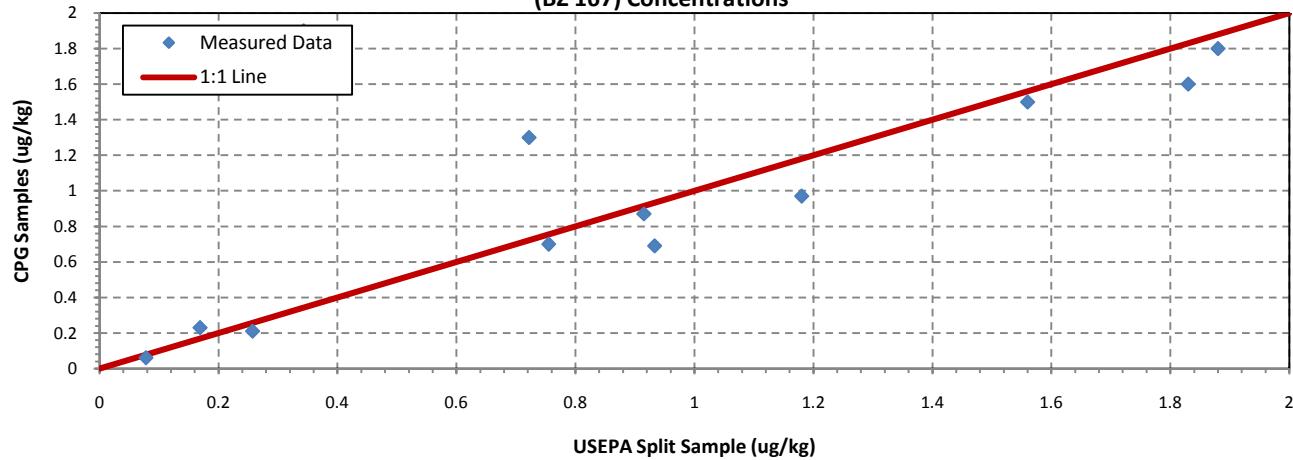


Figure 47c: Line Plot of 2,3',4,4',5,5'-Hexachlorobiphenyl (BZ 167) Percent Differences when USEPA and CPG both had Detected Concentrations

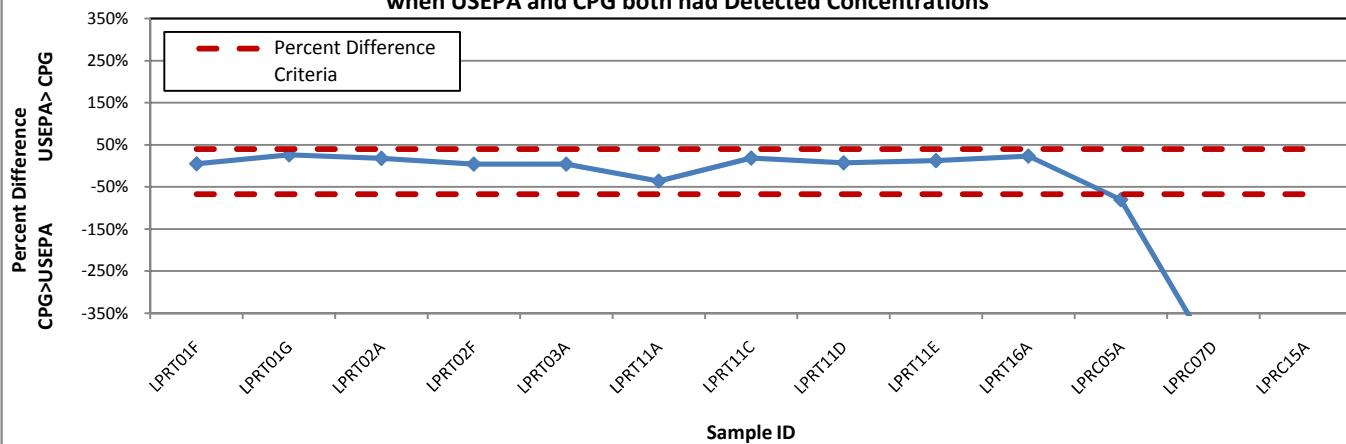


Figure 48a: Line Plot of 3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169) Concentrations

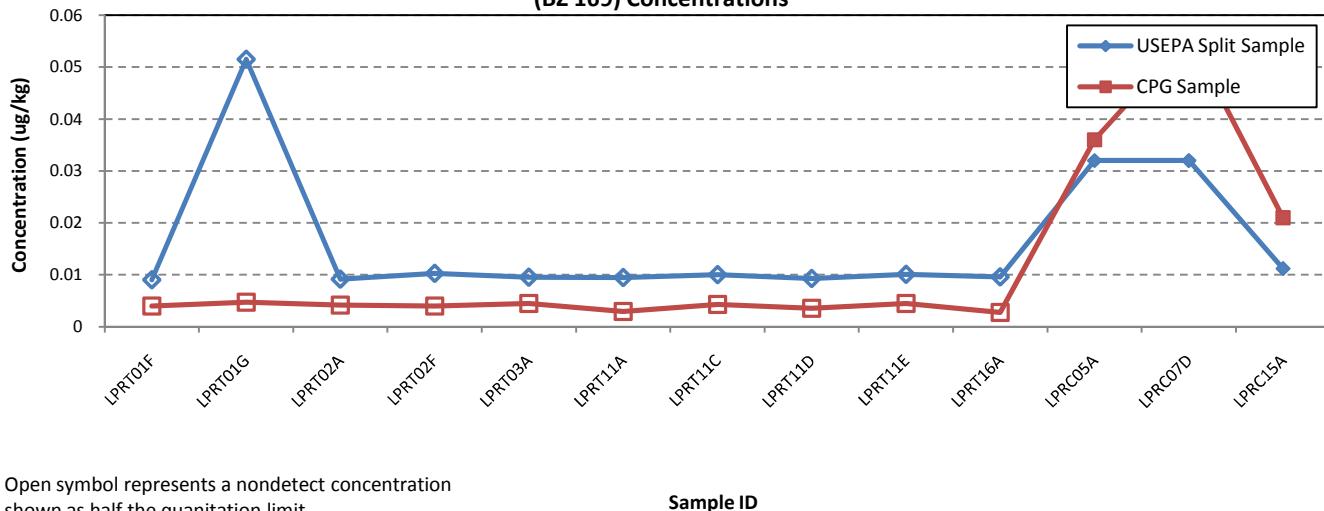


Figure 48b: Bivariate Plot of 3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169) Concentrations

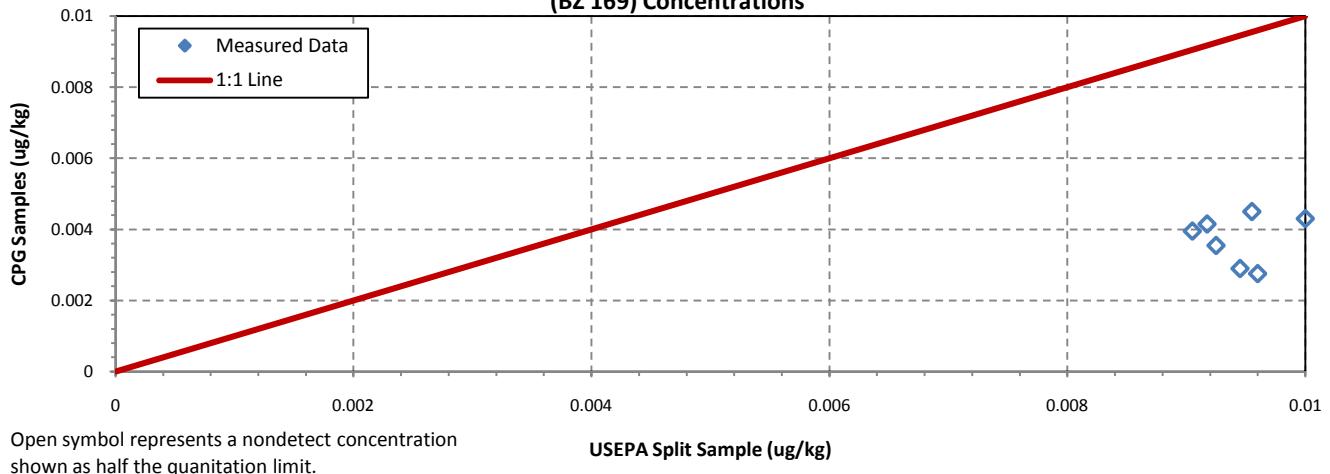


Figure 48c: Line Plot of 3,3',4,4',5,5'-Hexachlorobiphenyl (BZ 169) Percent Differences when USEPA and CPG both had Detected Concentrations

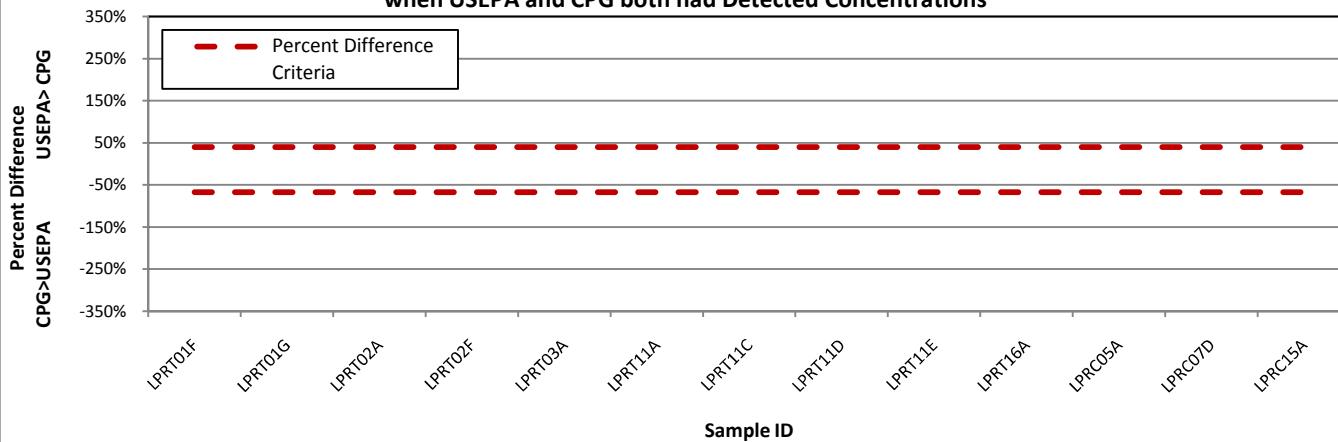


Figure 49a: Line Plot of 2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ 189) Concentrations

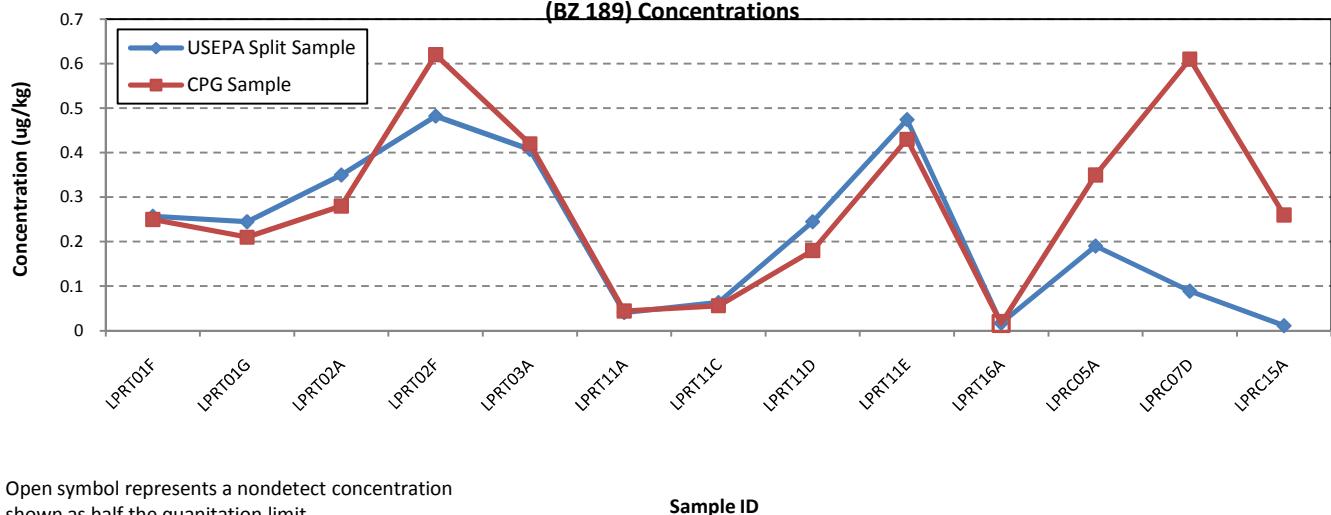


Figure 49b: Bivariate Plot of 2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ 189) Concentrations

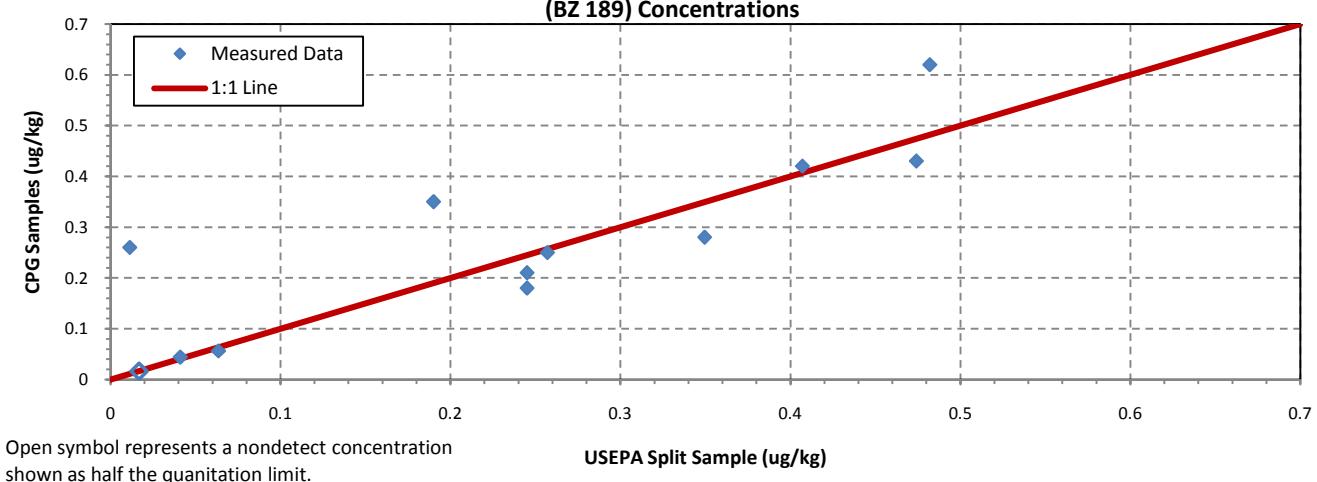


Figure 49c: Line Plot of 2,3,3',4,4',5,5'-Heptachlorobiphenyl (BZ 189) Percent Differences when USEPA and CPG both had Detected Concentrations

